ZooKeys 418: 1–103 (2014)
doi: 10.3897/zookeys.418.7629
www.zookeys.org

RESEARCH ARTICLE

A peer-reviewed open-access journal
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A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses of subfamilies and genera, keys to world species, and some new locality records

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Academic editor: *Vladimir Pesic* | Received 2 April 2014 | Accepted 5 June 2014 | Published 20 June 2014

http://zoobank.org/D71C8A3D-A6CA-40A5-B3A0-34A1FD1C16A0

Citation: Skvarla MJ, Fisher JR, Dowling APG (2014) A review of Cunaxidae (Acariformes, Trombidiformes): Histories and diagnoses of subfamilies and genera, keys to world species, and some new locality records. ZooKeys 418: 1–103. doi: 10.3897/zookeys.418.7629

Abstract

Cunaxidae are predaceous mites found in a variety of habitats. This work provides comprehensive keys to world subfamilies, genera, and species. Diagnoses and historical reviews are provided for subfamilies and genera.

Cunaxa boneti, *C. denmarki*, *C. exoterica*, *C. floridanus*, *C. lehmanae*, *C. lukoschusi*, *C. metzi*, *C. myabunderensis*, *C newyorkensis*, *C. rackae*, *C. reevesi*, and *C. reticulatus* are moved to *Rubroscirus* and *C. otiosus*, *C. valentis*, and *C. rasile* are returned to *Rubroscirus*. *Cunaxoides neopectinatus* is moved to *Pulaeus*. *Neocunaxoides pradhani* and *N. gilbertoi* are transferred to *Scutopalus*. *Pulaeus minutus* and *P. subterraneus* are moved to *Lupaeus*. *Pseudobonzia bakari*, *P. malookensis*, and *P. shamshadi* are transferred to *Neobonzia*. *Dactyloscirus bifidus* is transferred to *Armascirus*.

Scirula papillata is reported from the Western Hemisphere for the first time. *Armascirus ozarkensis*, *A. primigenius*, and *Dactyloscirus dolichosetosus* are reported from new localities.

Keywords

Identification, key, Bdelloidea, Prostigmata, Eupodina

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Introduction

Cunaxidae (Fig. 1) are common predatory mites that are present in forest systems, grasslands, agricultural fields, and anthropogenically disturbed areas. Surveys of mites in these habitats often report only family or generic-level identification. This is problematic because little is known about where cunaxid species occur, both regionally and in what habitats, and unfortunate because such reports are potentially very useful collectively if species were identified.

Part of the reason behind the lack of specific identification is the difficulty in reliably identifying cunaxids without extensive knowledge of the primary literature. Keys to cunaxid species are often regional, so of little use to researchers outside of that specific region, and scattered across countless journals. The last comprehensive attempt to present keys to world species was by Smiley (1992). The number of described species since Smiley published his monograph has more than doubled (166 to 400+). Updated keys reflecting known diversity and current taxonomic opinion are therefore imperative if researchers are to identify individuals to the specific rather than generic or family level.

Biology. All cunaxids are thought to be opportunistic predators, though an undescribed *Rubroscirus* was observed to drink drops of honeydew in addition to feeding on live prey (Walter and Proctor 1999). Cunaxids have been reported to feed on active prey such as Collembola (Sellnick 1926, Heryford 1965), bark lice (Zaher et al.1975a), and thrips (Milne 1977), and relatively inactive prey such as scales (Ewing and Webster 1912, Gerson 1971), nematodes (Taha et al. 1988, Walter and Kaplan1991), phytophagous mites (Meyer and Ryke 1959, Zaher et al. 1975a, Den Heyer and Ryke 1970, Taha et al. 1988, Smiley 1992, Sathiamma 1995, Arbabi and Singh 2000, Ferla 2001, Lahiri et al. 2004, Castro and Moraes 2010), and paratydeid mites (pers. obs.). They fail to survive when offered only plant material (Zaher et al. 1975a).

Both ambush and active hunting have evolved within the family, sometimes within the same subfamily. Within Cunaxinae, for instance, *Armascirus* and *Dactyloscirus* wait, sometimes for hours, to ambush prey (Walter and Proctor 1999), whereas *Allocunaxa* actively search for prey (Castro and Moraes 2010).

Cunaxids occur in most terrestrial habitats, including soil and leaf litter (Den Heyer 1977a, Luxton 1982; Javan et al. 2012); moss and lichen (Sepasgosarian 1978, Tseng 1980); on vegetation (Miller 1925, Swift and Goff 2001, Ferla and Moraes 2002) including coniferous trees (Lehman 1982), tropical trees (Castro and Moraes 2007) including guava trees (Mallikarjunappa and Nageshchandra 1990), Ferla and Moraes 2002), mango trees (Mohamed et al. 2014), coconut trees (Mariau and Biggins 2001; da Silva et al. 2014), and rubber trees (Hernandes and Feres 2006), ornamental plants (Tagore and Putatunda 2003), invasive weeds (Walter 1999), agricultural plants such as citrus trees (Muma 1960, Olivier 1968, Ramsey et al. 1972a, Soliman and Mahfood 1978, Vacante and Nucifora 1986, Quilici et al. 1997, Grout and Ueckermann 1999, Ferla and Moraes 2002, Fadamiro et al. 2009), deciduous fruit trees (Nesbitt 1946,

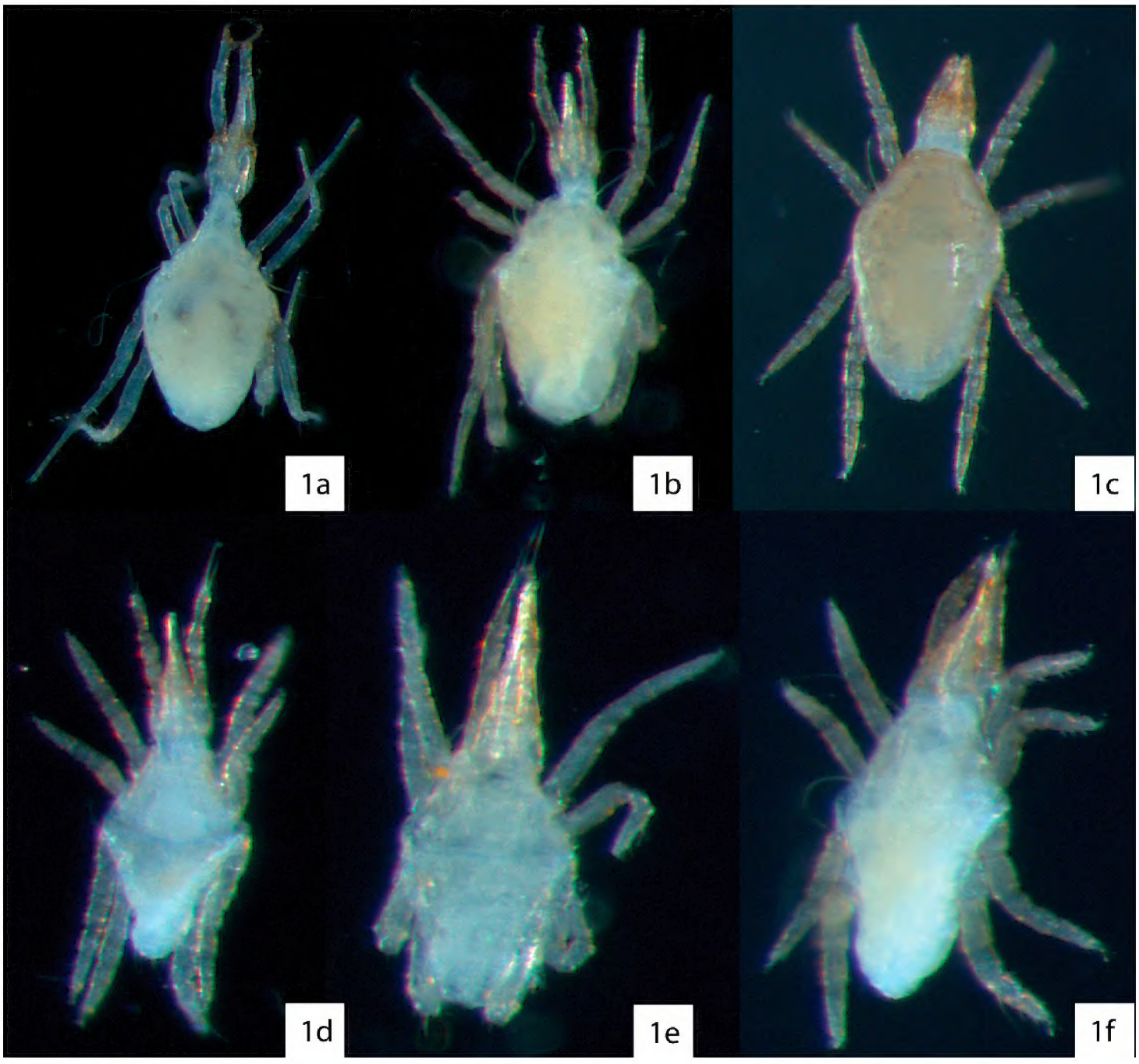


Figure 1. Examples of cunaxids in ethanol illustrating how they would appear while sorting. **1a** *Armascirus* **1b** *Cunaxa* **1c** *Pulaeus* **1d** *Parabonzia* **1e** *Coleoscirus* **1f** *Neobonzia.*

Garman 1948, Lord 1949, Ramsey et al. 1972b, Quilici et al. 1997, Ferla and Moraes 1998, Ferla and Moraes 2002; Shakhsi Zare et al. 2012), cotton (Kuznetzov and Sizova 1978), strawberries (Ferla et al. 2007), grape vineyards (Schruft 1971, Jubb et al. 1985, Molnar 1997), alfalfa fields (Badieritakis et al. 2014), and plants in urban settings (Lahiri et al. 2004); vertebrate nests (Garman 1948, Gupta and Chattopadhyay 1978, Gupta and Paul 1985, Estebanes-Gonzales 1997); caves (Cooreman 1954, Turk 1972, Zacharda 1978); animal debris (Corpuz Raros et al. 1988, Taha et al. 1988); tree holes (Atyeo 1958, Lin and Zhang 2002); house dust (Oliveria and Daemon 2003); and stored food products (Huges 1976, Tseng 1980, Fan 1992). Individual species, however, are thought to be restricted to a particular habitat. For example, *Armascirus taurus* is reported to be most prevalent on the leaves of citrus trees while *Coleoscirus simplex* and *C. curtipalpus* are more common in the leaf litter (Muma 1965) and *Parabonzia bdelliformis* is usually collected from treeholes but not nearby litter (Smiley 1992).

While cunaxids are often often found on plants in agricultural settings, their effect on prey populations is unclear. Ewing and Webster (1912) observed *Cunaxoides parvus* feeding on oyster-shell scales on apple trees and Schruft (1971) reported *C. oliveri* feeding on eriophyid mites on grapes. Sathiamma (1995) reported *Cunaxa setirostris* to be "a very active and efficient predator on all the motile stages of *Oligonychus iseilemae* [white spider mite]" and that the "predator larva preferred the larval prey; nymphal predator preferred the larvae and early nymphs of the prey and the adult preferred the prey nymphs and adults". Nucifora and Vacante (1986) reported cunaxids to be auxiliary predators that are useful for crops, but not main predators used in "integrated control techniques". Rigorous studies investigating the effect of cunaxids on prey populations, however, have not been conducted.

Cunaxids appear to be active year round. Den Heyer (1980a) collected all life stages of *Neocunaxoides* in the Transvaal Highveld during the summer (30 °C+) and winter (minimum 0 °C) months. Zaher et al. (1975b) collected cunaxids throughout the year and demonstrated a positive correlation between abundance and temperature; they also found a slight negative correlation between abundance and relative humidity.

Cunaxids have been reported to be found phoretically on bark beetles, though they were not identified to species (Penttinen et al. 2013).

Both sexual reproduction and thelytokous parthenogenesis have been reported in cunaxids (Walter and Proctor 1999, Castro and Moraes 2010). Within Cunaxinae, Coleoscirinae, and Cunaxoidinae, precopulatory guarding of the quiescent tritonymphal female has been reported (Walter and Kaplan 1991). *Dactyloscirus* males possess a well-developed, sclerotized aedeagus; *Armascirus* and *Rubroscirus* males also possess an aedeagus, though less developed and sclerotized than in *Dactyloscirus* (Den Heyer 1978a, 1979a, 1981a). Castro and Moraes (2010) suggest that *Cunaxatricha tarsospinosa* may be cyclically or facultatively parthenogenetic – one population they studied consisted entirely of females while another population approximately 450 km distant contained males – and that parthenogenesis may be induced by cellular endosymbionts.

Cunaxids spin silk, which is used for a variety of purposes. *Cunaxatricha tarsospinosa* produces a webbing around eggs laid on leaves, but not branches; Castro and Moraes (2010) report that destruction of webbing may reduce viability of the eggs. Nymphal *Armascirus taurus*, *Dactyloscirus inermis*, *Coleoscirus simplex*, and an undescribed *Pulaeus* construct silken molting chambers (Alberti and Ehrnsberger 1977; Walter and Kaplan 1991); the breadth of this behavior suggests it may be widespread among cunaxids. *Cunaxa setirostris* constructs an irregular net of two silk varieties which is used during prey capture (Alberti and Ehrnsberger 1977). It has also been proposed that some species may be venomous, though this has not been confirmed (Den Heyer 1980a, Smiley 1992, Walter and Proctor 1999).

Biogeography. Cunaxids have been found on every continent except Antarctica. South Africa and the Philippines have the most well-documented cunaxid diversity – 68 and 57 species respectively – thanks to the efforts of Den Heyer and Corpuz-Raros

(Den Heyer 2011a). South America was little studied until Castro and Den Heyer described 8 genera and 10 species from Brazil between 2008 and 2009. Only two species are known from Australia, both reported by Womersley (1933), though Walter (1999) reported 5 undescribed species in 4 genera and Callan et al. (2011) reported another two species at the family level, suggesting many species await discovery there.

The cunaxid fauna of Europe and North America north of Mexico fall between these extremes. Most reports have been sporadic and span more than a century, beginning with Banks (1894) in the United States and Berlese (1887) in Europe. Robert L. Smiley, a well-known North American worker, never collected material. He instead worked on samples that were sent to him, often intercepted by the USDA at ports of entry, so rather than focusing on North American fauna he more generally worked on world species. This has led to a scattered understanding of the species and genera that occur in North America.

Methods

The diagnoses and keys presented are based on published descriptions and examination of available type specimens. However, for many species the types were not available for examination. The accuracy of the keys is therefore dependent upon the accuracy of the published descriptions. This also influenced which characters were chosen for couplets. Often a character that is potentially useful and informative (such as the presence or absence of a cheliceral seta) was not reported in the original description. Thus, unlike previous keys, characters such as setal counts of leg segments were often preferred. This may prove to be problematic as extra setae are sometimes reported on leg segments; however, examination of multiple specimens in a population should help overcome this.

Den Heyer (2011b, 2013) transferred many species into different genera in the Bdelloidea database that is used by Species 2000 and ITIS Catalogue of Life (CoL). However, nomenclatural acts proposed within these databases are not considered valid under The International Code of Zoological Nomenclature as they do not conform to Article 8.4.2.2. This is intentional for a number of reasons, including avoiding circularity (e.g., a paper that cites CoL about a nomenclatural act, and CoL citing that paper) and time limitations in pursuing a publication that includes all nomenclatural acts proposed within the databases each year (Roskov and Bailly, 2 May 2014, pers. comm.).

Terminology

An effort is made to utilize terminology that is broadly applicable and well-accepted across mite taxa, despite conventions used among bdelloid researchers. Some terms widely used by bdelloid researchers are either inaccurate or outdated, and others are

misleading. Therefore, we follow the suggestions outlined by Fisher et al. (2011), which are elaborated upon below.

Subcapitulum. The part of the gnathosoma that bears the palps and chelicerae has been variously termed by researchers of Bdelloidea. One such term – hypostome – more properly refers to the area of the subcapitulum anterior to the oral opening (Evans 1992; Krantz and Walter 2009), and therefore its use in reference to the entire subcapitulum is incorrect. The other term – hypognathum – is synonymous with subcapitulum, and is therefore not inaccurate, but also not broadly used across mite taxa. Thus, we reject the use of hypognathum in favor of subcapitulum and reserve the use of hypostome to the region of the subcapitulum anterior to the oral opening.

Body segmentation. The terminology associated with the acariform idiosoma remains controversial. Classically, these regions have been most widely called the propodosoma and hysterosoma. However, Grandjean (1970) proposed an alternate view of acariform idiosomal organization based on a segmentation hypothesis of van der Hammen (1963). Grandjean postulated that the podosoma is dorsally overtaken by the gnathosoma and the opisthosoma and termed the outgrowth of the gnathosoma that obscures the propodosoma the 'aspidosoma'. Under this hypothesis, referring to the anterio-dorsal half of the idiosoma as the propodosoma is inaccurate, while referring to posterio-dorsal idiosoma as the hysterosoma (opisthosoma + metapodosma) is more inclusive than necessary and should instead be denoted simply as the opisthosoma. This hypothesis has gained popularity and 'aspidosoma' is currently used across disparate acariform taxa (e.g., Caeculidae: Coineau 1974; Erythraeidae: Mąkol 2010; Penthalodidae: Jesionowska 2010; Tydeidae: Kazmierski 2008). Contrary to this, Weigmann (2001) pointed out there is neither evidence for the dorsal overgrowth of the gnathosoma obscuring the propodosoma, nor for the overgrowth of the opisthosoma obscuring the metapodosoma. Further, he provided good evidence for retaining 'propodosoma' and 'hysterosoma'. Ultimately, this matter will not be resolved without detailed investigation into developmental biology. Barnett and Thomas (2012, 2013) investigated the embryology of an oribatid (*Archegozetes longisetosus* Aoki, 1965) and demonstrated the opisthosoma of that mite comprises only two segments. Unfortunately, their investigations are as yet unable to resolve the problem of the dorsal podosoma.

Fisher et al. (2011) proposed avoiding hypothesis-dependent terminology pending further evidence for a given hypothesis. Thus, they retained 'hysterosoma' to refer to the idiosoma posterior to the sejugal furrow and implemented 'proterosoma' for the anterior idiosoma. Both terms were considered hypothesis-independent, but suffered from being more inclusive than necessary. Regardless, 'hysterosoma' is already used by many authors to refer to the dorsum posterior to the sejugal furrow, therefore its implementation is uncontroversial. Conversely, 'proterosoma' is not widely used to refer to the anterior idiosoma. Thus, referring to those setae as 'proterosomal setae' is novel, and therefore less preferred. However, recent investigations provide some support for implementing 'proterosoma' – this is discussed below.

Phylogenetic analyses of large datasets that include molecular data has corroborated previous suspicions of the non-monophyly of "Acari" and provided substantial support for a clade that combines camel spiders with acariforms called Poecilophysidea (Dabert et al. 2010, Pepato et al. 2010). In addition to characteristics of the reproductive system that have been previously noted (Alberti 1980a, b, 2000, Alberti and Peretti 2002, Klann et al. 2009), Dunlop et al. (2012) suggested that the sejugal furrow of Acariformes is homologous to a similar body division in Solifugae, lending another potential synapomorphy for this clade. Because of this, the sejugal furrow was elevated as a key morphological trait among both camel spiders and acariforms, which now makes it possible to construct terminology founded in a well-supported hypothesis. This renders terms that are denoted relative to the sejugal furrow (like 'proterosoma' and 'hysterosoma') as hypothesis-dependent, which is only preferred over hypothesis-independent terminology when the hypothesis is well-supported.

Therefore, we continue with the suggestions of Fisher et al (2011) in using 'proterosoma' and 'hysterosoma' for two reasons: 1) they are hypothesis-independent with respect to Grandjean's 'aspidosoma' and Weigmann's 'propodosoma'; and 2) since 2011, they have been found to be hypothesis-dependent, but on well-supported hypotheses. Obviously, as future research resolves the issue of the acariform idiosomal dorsum (i.e. Grandjean vs. Weigmann), we suggest that new terminology based on those hypotheses should be adopted.

Idiosomal setae. For hysterosomal setae, we follow the notation of Grandjean (1939, 1947) that has been widely adopted by acarologists (e.g., van der Hammen 1970; Lindquist 1976, 1977; Kethley 1990; Swift 1996). However, proterosomal setae remain problematic. Historically, proterosomal chaetotaxy followed Grandjean (1939, 1947), which identified internal/external verticals (*vi* and *ve*) and internal/external scapulars (*sci* and *sce*). This notation has always been cumbersome for groups like Bdelloidea which have *sci* always external to *sce*. Given that homology has not been determined for these setae across mite taxa, some authors suggested simply switching the designations of *sci* and *sce* to reflect their position (Den Heyer and Castro 2008a, b, c; Den Heyer 2011c). As a result, frustratingly, the literature now has both *sci* and *sce* referring to each set of setae.

Therefore, we reject the suggestion of Den Heyer and Castro (2008) and follow the suggestion of Fisher et al. (2011), which resorts to a modified version of Atyeo (1960) when referring to proterosomal setae: anterior/posterior trichobothria (*at*/*pt*), and lateral/median proterosomal setae (*lps*/*mps*). Obviously, once homology of these setae can be determined across mite taxa, we suggest revising the terminology accordingly.

Abbreviations. The following abbreviations (Fig. 2) are used: attenuate solenidion (asl), blunt rod-like solenidion (bsl), famulus (fam)(=peg organ), microseta (mst), solenidion (s) (this is used only when a description does not specify what type of solenidion and may refer to any solenidion type), spine-like seta (spls), simple tactile seta (sts), trichobothrium (T). When setal types are not specified (e.g., coxae I–IV setal formula 5-5-4-3) it is assumed all setae are simple (sts).

Illustrations were produced using the methods outlined by Fisher and Dowling (2010).

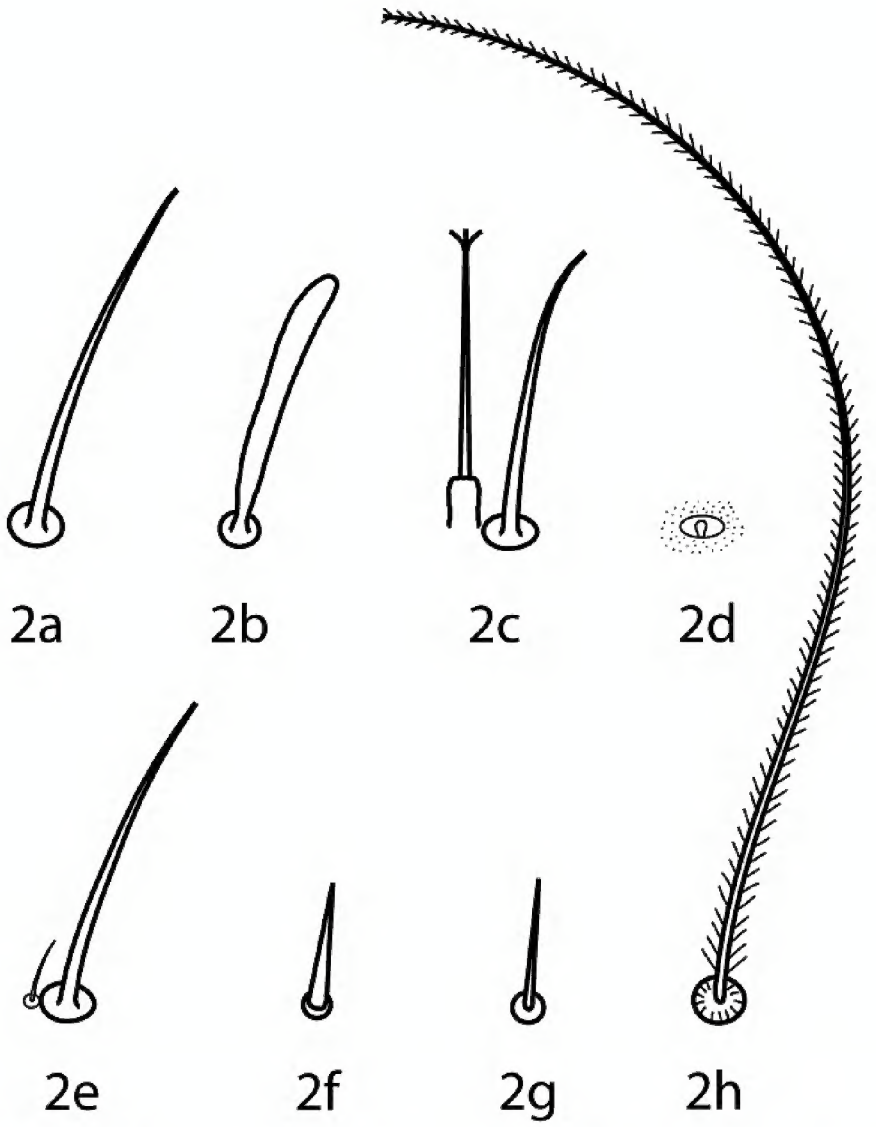


Figure 2. Setal types. Relative sizes will vary within a given setal type **2a** Attenuate solenidion (asl) **2b** Blunt rod-like solenidion (bsl) **2c** Elongate, tri-pronged famulus (fam), as seen in *Dactyloscirus* **2d** Famulus (fam), as seen in the majority of cunaxids **2e** Duplex setae - microseta (mst) and attenuate solenidion **2f** Spine-like seta (spls) **2g** Simple tactile seta (sts) **2h** Trichobothrium (T).

Systematics

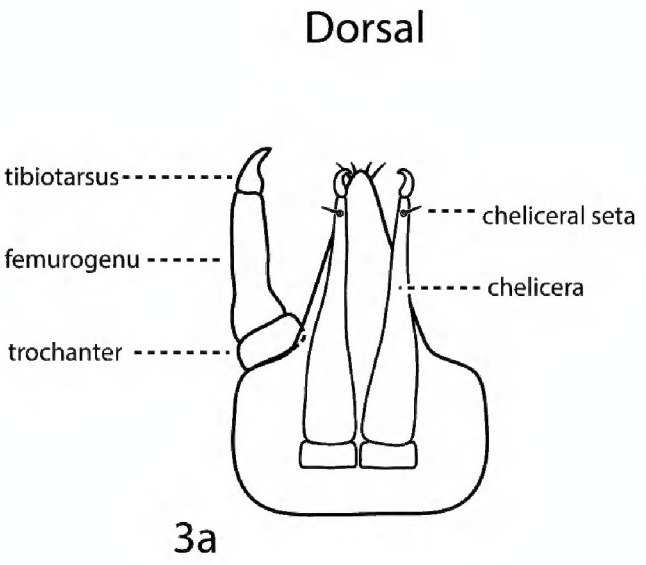
Cunaxidae Thor, 1902

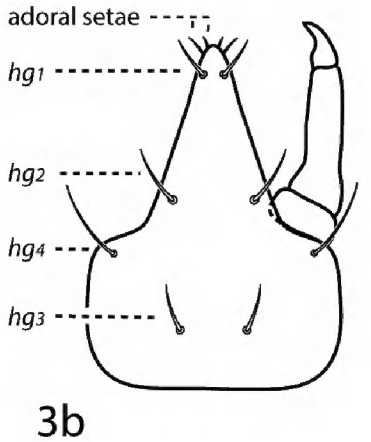
Historical review. Linnæus (1758) described *Acarus* and included all mites therein. Hermann separated three mite species with elongated gnathosomas (i.e., Bdellidae and Cunaxidae) from *Acarus* into *Scirus*. However, Hermann died in 1794 and his papers were not published until after his death by his brother-in-law F. L. Hammer in 1804 (as Hermann 1804). Latreille (1795) had by then separated the same mites into *Bdella*. Von Heyden (1826), recognizing that *Bdella* had priority over *Scirus*, synonomised *Scirus* with *Bdella* and erected *Cyta* and *Cunaxa*. However, many authors, including Dugés (1834a), Kramer (1881, Banks (1894), and Berlese (1904, 1910), continued to describe new species in *Scirus*. Dugés (1834a) erected Bdellidae (Bdelloidea) for *Bdella* and *Scirus*, having apparently not seen Von Heyden's synonymization of the two genera. Trouessart (1892) moved *Cunaxa* from Bdellidae to Trombidiidae and erected the subfamily Scirinae. Oudemans (1902) used Cunaxinae in the same sense that Trouessart (1892) used Scirinae, that is

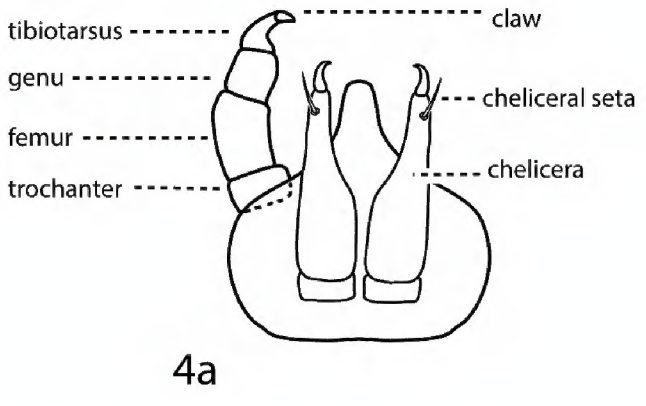
for those mites in the family Bdellidae (*sensu* Dugés) that have pedipalps with a curved terminal segment and movable chela only (= Cunaxidae *sensu* Thor). Thor (1902) erected Cunaxidae as a family separate from Bdellidae. Oudemans (1906) disregarded Thor's (1902) erection of Cunaxidae and kept Cunaxinae as a subfamily within Bdellidae. Van der Hammen (1972) erected the superfamily Cunaxoidea over Bdelloidea, disregarding the priority of *Bdella* Latreille (1795) over *Cunaxa* Von Heyden (1826). Den Heyer (1977b) erected Bonziinae for *Bonzia* and *Parabonzia*. Den Heyer (1978a) preserved the name Cunaxinae, but limited its concept to those cunaxids possessing 5-segmented pedipalps which extend past the subcapitulum by at least the distal two segments. Den Heyer (1978b) erected Coleoscirinae. Den Heyer (1980c) erected the monobasic Scirulinae and recognized the priority of Bdelloidea over Cunaxoidea. Bu and Li (1987a) erected Orangescirulinae. Smiley (1992) erected Denheyernaxoidinae, Neobonzinae, and Paracunaxoidinae as monotypic subfamilies and monographed and provided keys to known species. Den Heyer and Castro (2009) moved *Denheyernaxoides* and *Paracunaxoides* to Cunaxoidinae, thus disregarding Denheyernaxoidinae and Paracunaxoidinae as valid subfamilies. Lin and Zhang (2010) provided a detailed historical review of Cunaxidae in China and a checklist of species found in that country. Den Heyer (2011) moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae, and synonymized *Coleobonzia* with *Neobonzia*.

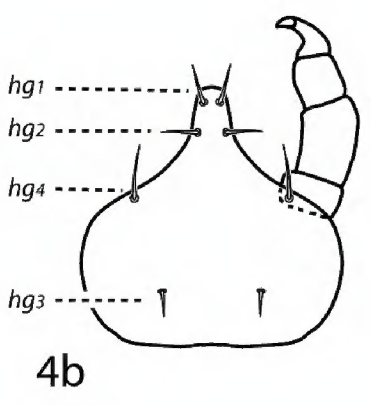
Diagnosis. *Gnathosoma* (Figs 3–6). **Pedipalps** 3-, 4-, or 5-segmented and end in a strong claw (except in *Pseudobonzia*). They may be shorter than, equal to, or extend beyond the distal end of the subcapitulum. Femora of 5-segmented pedipalps divided into basi- and telofemora, though may be secondarily fused; a dark line often indicates the previous articulation (Fig. 5a, b illustrate a fully divided femur and Fig. 6a, b illustrate a secondarily fused femur. This is for illustration purposes only, i.e., cunaxids with long and short 5-segmented pedipalps may have either fully divided or secondarily fused femora). Telofemora and genua are uniquely fused in *Allocunaxa*, though the basifemoral/telofemoral articulation is present. Apophyses present or not on the telofemora, adjoining the genua and tibiotarsi, or on the tibiotarsi. Subcapitulum wedge-shaped and may be patterned with random dots or papillae, dots or papillae forming lines, a single row of cells on the posterior edge, or reticulations forming polygonal cells. **Subcapitulum** with up to 6 pairs of setae are present: $hg_{1–4}$ and 2 pairs of adoral setae. Seta hg_1 usually straight, but geniculate in Bonziinae and may be curved in *Neoscirula*; hg_4 often longest pair of subcapitular setae. **Chelicerae** with or without seta near the cheliceral digit.

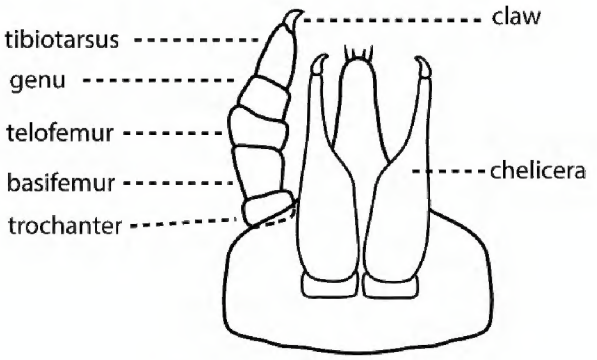
Idiosoma, dorsal (Fig. 7a). Idiosoma diamond-shaped. Dorsal proterosoma covered with a sclerotized shield that bears 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*); rarely one pair of setae or sensillae absent. Dorsal hysterosoma complemented with 0–2 large shields or plates and 0–4 pairs of platelets. These plates and platelets may capture one or more pairs of setae. Up to 8 pairs of dorsal hysterosomal setae present (c_1–h_1, c_2, f_2, and h_2); h_2 may occur ventrally. Setae may occur on small platelets that are barely larger than the setal socket. Integument not covered in shields, plates, or

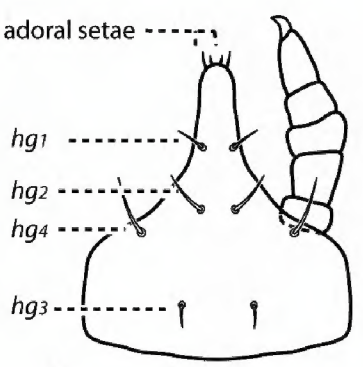


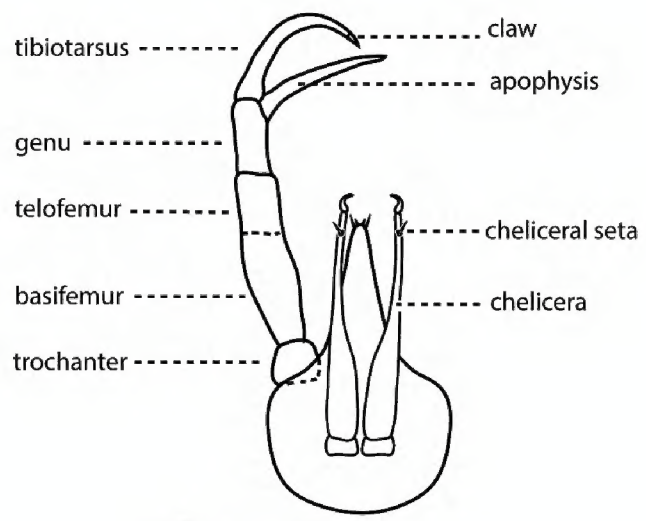


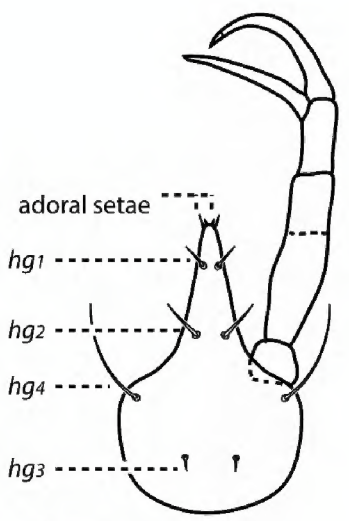












Figures 3–6. a. dorsal. b. ventral. **3** 3-segmented pedipalp (Cunaxoidinae) **4** 4-segmented pedipalp (Scirulinae) **5** 5-segmented pedipalp that does not extend beyond the subcapitulum by more than the distal half of the genua (Bonziinae, Coleoscirinae, and Orangescirulinae) **6** 5-segmented pedipalp that reaches beyond the subcapitulum by at least the distal half of the genua (Cunaxinae).

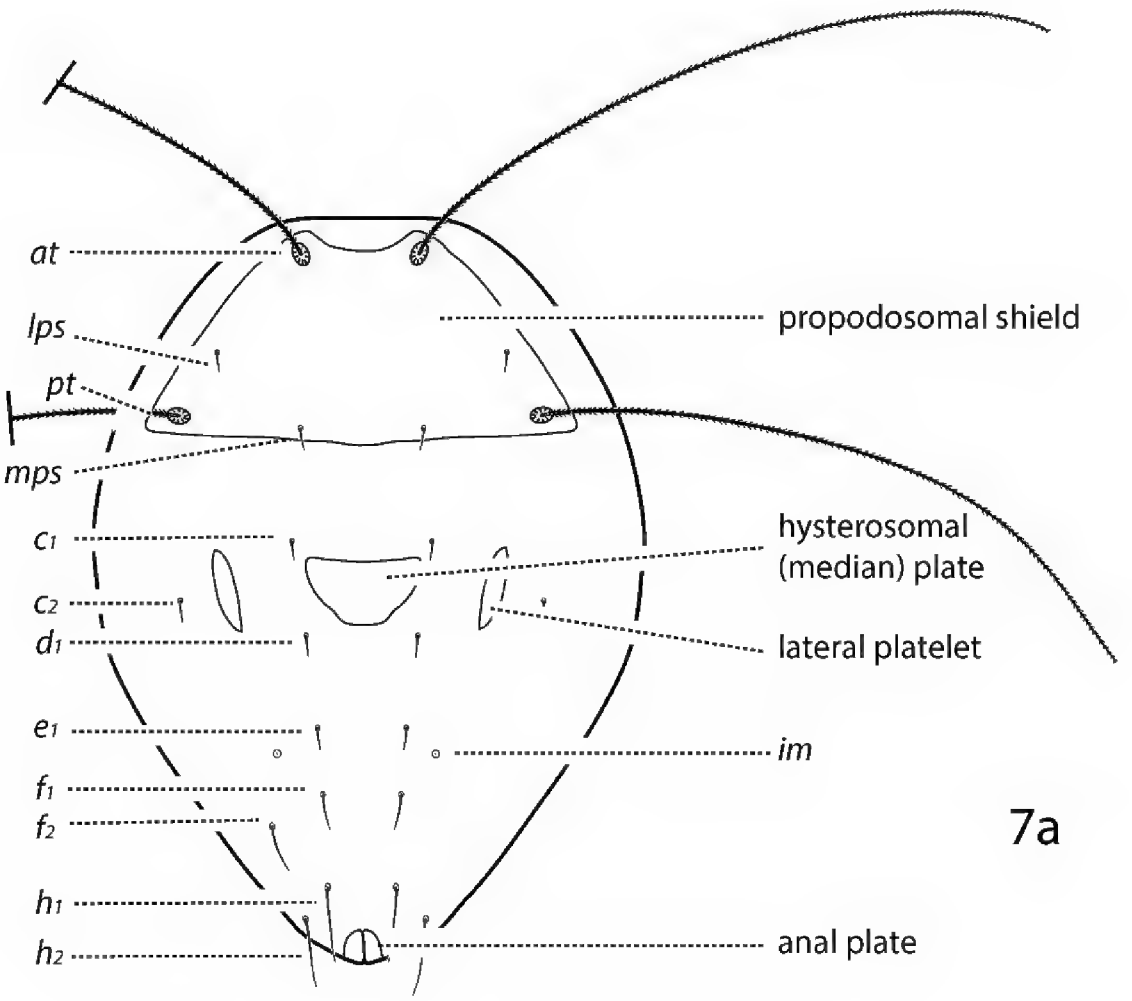


Figure 7. Generalized schematic of cunaxid idiosomal morphology. **7a** Dorsal. **7b** Ventral.

platelets is striated. Cupule *im* present, usually laterad and slightly posterior to e_1. Dorsal idiosomal shields and plates smooth or patterned with random dots or papillae, dots or papillae forming lines, reticulations forming polygonal cells, or cells which form rows.

Idiosoma, ventral (Fig. 7b) Ventral idiosoma may be complemented with 1 or a few small platelets in addition to the coxae. **Coxae** fused to body and form plates. Coxae I–II are often fused in adults and may coalesce medially to form a sternal shield. Coxae III–IV are often fused in adults and may extend caudally beyond the genital plates. Each coxa complemented with 0–4 setae; in addition, extensive coxae or sternal shields may capture setae normally on the integument and therefore have more. Coxae may be plain or patterned with random dots or papillae, dots or papillae forming lines, or reticulations forming polygonal cells. Genital plates (sometimes called anal valves) present in adults and bear 3 (rarely) or 4 (usually) setae, except in *Parabonzia* which have up to 9 pairs of setae. 2 pairs of genital papillae visible underneath the plates. Anal plates (sometimes called anal valves) bear 1–2 setae ($ps_{1\text{-}2}$). Setae ps_2 may occur off the anal plates. **Legs** 6-segmented in larvae, 7-segmented in nymphs and adults. In adults these segments are coxa, trochanter, baifemur, telofemur, genu, tibia, and tarsus, however, the coxae are often treated separately from the other leg articles. Femora undivided in larvae. Trichobothrium present on leg tibia IV. Ambulacral claws present on either side of a 4-rayed empodium.

Key to Subfamilies of Cunaxidae (modified from Smiley 1992)

1	Pedipalpal telofemoral multi-branched seta present (except *Parabonzia mindanensis*) (Fig. 7a) ..... **Bonziinae**
–	Pedipalpal telofemoral multi-branched seta absent **2**
2 (1)	Pedipalps 3-segmented (Figs 3a,b) ..... **Cunaxoidinae**
–	Pedipalps 4-segmented (Figs 4a,b) ..... **Scirulinae**
–	Pedipalps 5-segmented (basi-and telofemora may be partially fused) (Figs 5a, b; 6a, b) **3**
3 (2)	Pedipalps extend beyond the subcapitulum by at most the distal half of the tibiae (Figs 5a, b) **4**
–	Pedipalps extend beyond the subcapitulum by at least the distal half of the tibiae (Figs 6a,b) ..... **Cunaxinae**
4 (3)	Trichobothrium on tibiae IV present; setae hg1 not geniculate; cheliceral seta usually present ..... **Coleoscirinae**
–	Trichobothrium on tibiae IV absent; setae hg_1 geniculate; cheliceral seta absent ..... **Orangescirulinae**

Bonzinae Oudemans, 1927

Historical review. Oudemans (1927) erected *Bonzia* within Cunaxidae for *B. halacaroides*. Smiley (1975) erected *Parabonzia* for *Bonzia bdelliformis*. Den Heyer (1975) erected *Cunabdella* for *C. marthae*. Den Heyer (1977b) erected Bonzinae for the two genera; he also moved *C. marthae* to *Parabonzia*, effectively synonymizing *Cunabdella* with *Parabonzia*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A multi-branched seta present dorsally on the telofemora. Tibiotarsi terminate in a stout claw or two strong setae. 2 pairs of adoral setae present or absent. **Subcapitulum** with 4 pairs of setae ($hg_{1–4}$) present in *Bonzia*; up to 6 pairs of subcapitular setae (hg_{1-4} + additional setae) present in *Parabonzia*.

Idiosoma, dorsal. Proterosoma bears a shield complemented with 2 pairs of setae (*at* and *pt*) and 2 pairs of setose sensillae (*lps* and *mps*). Dorsal hysterosoma may bear a shield; if a shield is present it may be complemented with a variable number of setae depending on the extent of the shield. Setae c_1–h_1, c_2, f_2 and h_2 present and are smooth or spiculate. Cupule *im* present laterad and caudally of e_1. Integument that does not bear shields or plates is striated.

Idiosoma, ventral. **Coxae** I–II fused or not and coxae III–IV fused or not. Genital plates bear 4–9 setae; 2 pairs of genital papillae visible underneath the plates. Up to 4 pairs of setae present on the anal plates. Up to 9 pairs of setae present on the integument between coxae II and the anal plates. **Legs.** Trichobothrium present on leg tibia IV. The ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female Bonziinae (modified from Smiley 1992)

1 Pedipalp tibiotarsal claw present; 2 pedipalp tibiotarsal spine-like tubercles present (Fig. 8b); genital plates with 4 pairs of setae; internal genital setae absent ..... ***Bonzia* Oudemans, 1927**

– Pedipalp tibiotarsal claw absent; 2 pedipalp tibiotarsal spine-like tubercles absent (Fig. 8c); genital plates with 5–9 pairs of setae; internal genital setae present ..... ***Parabonzia* Smiley, 1975**

Bonzia Oudemans, 1927

Historical review. Oudemans (1927) erected *Bonzia* for *B. halacaroides*. Willmann (1939) described *B. sphagnicola* from Germany. Willmann (1950) described *B. rufofusca*. *Bonzia brownei* was described by Turk (1972). Den Heyer (1977) provided a detailed redescription of type material of this genus. Kuznetzov and Livshitz (1979) reported *Bonzia* from Russia. Michocka (1987) reported *B. halacaroides* from Poland. Smiley (1992) described *B. woodi* and *B. yunkeri* and synonymized *B. rufofusca* and *B. brownei* with *B. halacaroides*. Skvarla et al. reported *B. yunkeri* from the Ozark Mountains in Arkansas.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A dorsal multi-branched seta present on the telofemora. The tibiotarsi terminate in a stout claw. 2 pairs of adoral setae present or absent. **Subcapitulum** with 4 pairs of setae ($hg_{1–4}$) present. Setae hg_1 are geniculate.

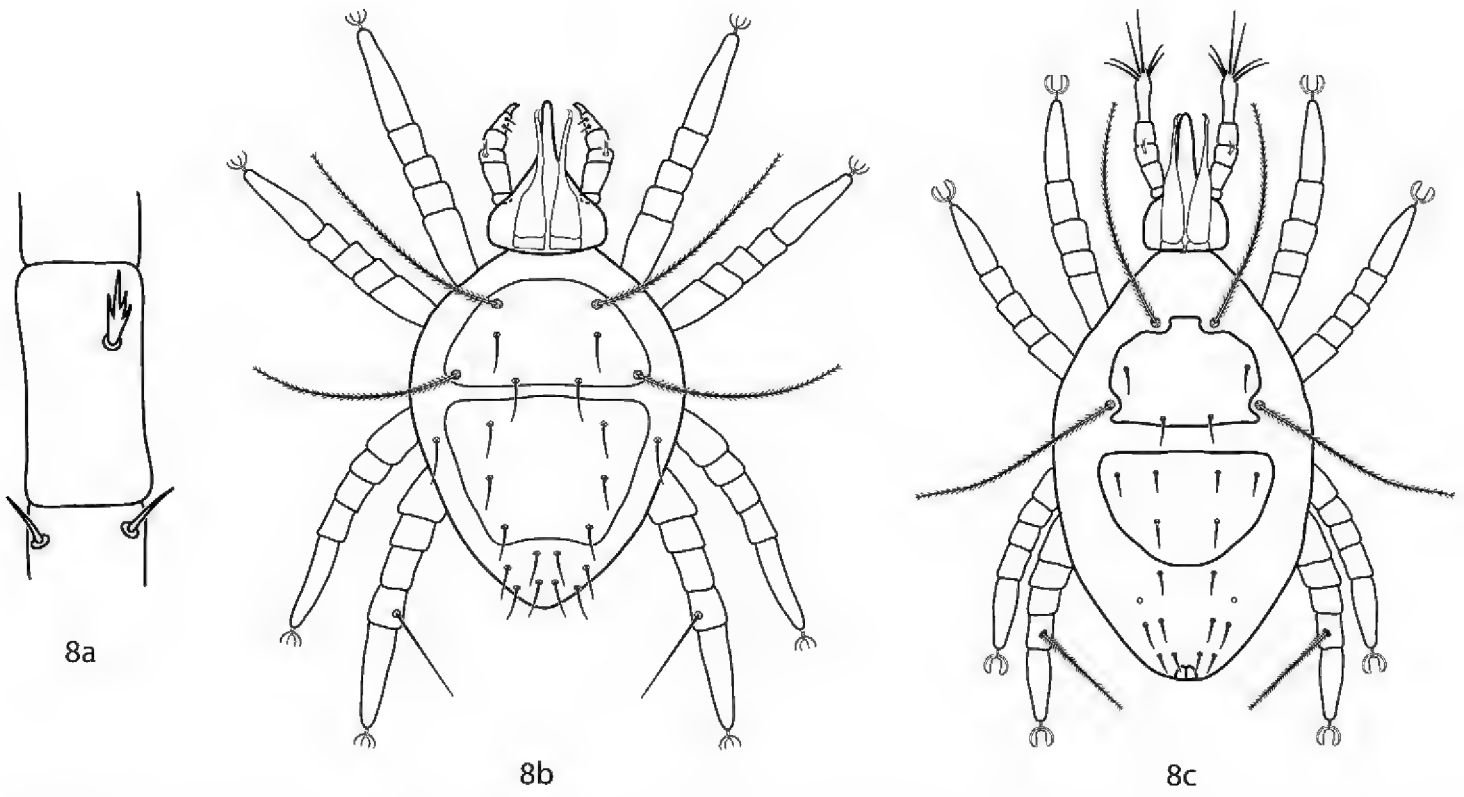


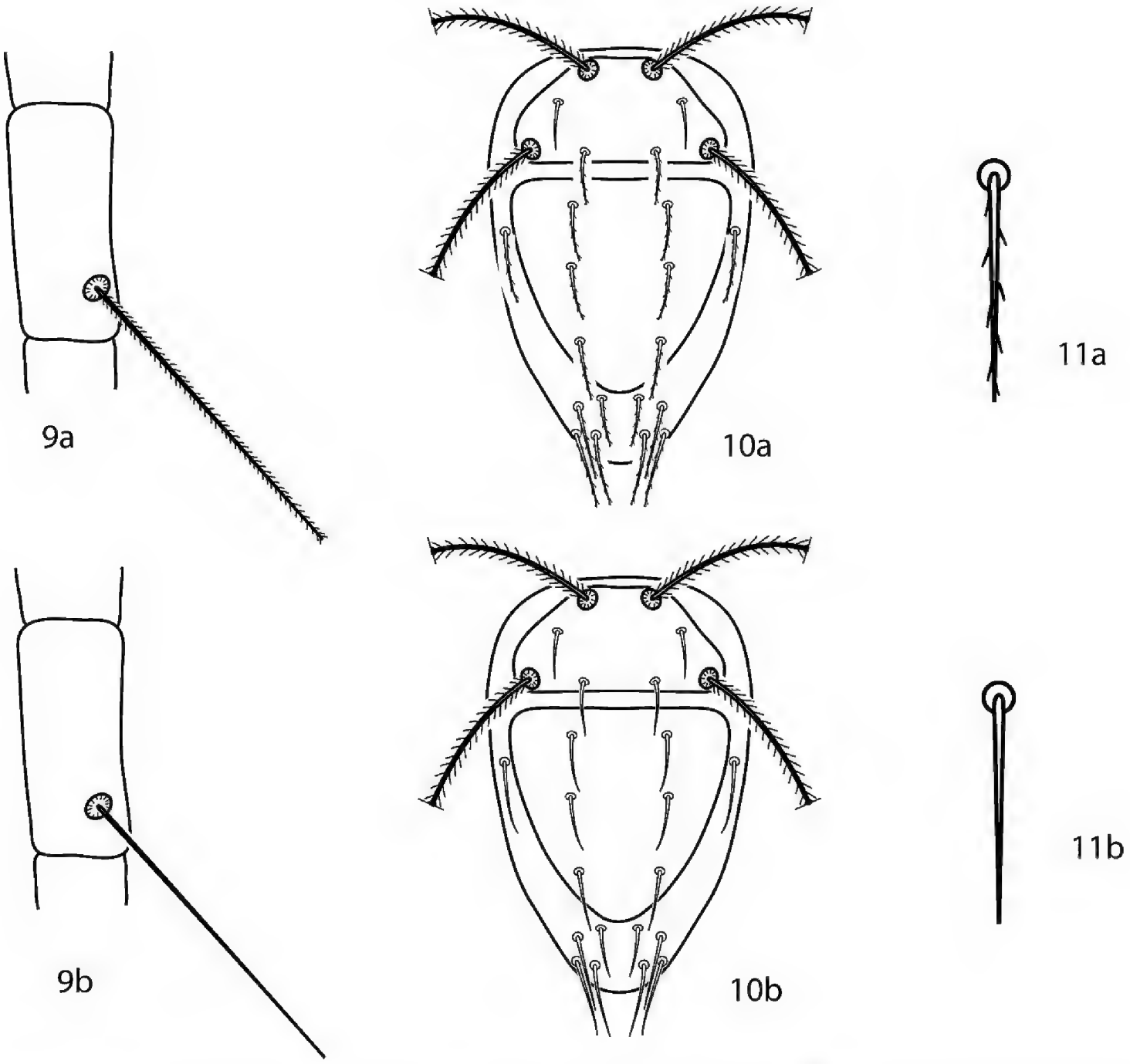
Figure 8. Bonziinae key illustrations. **8a** Telofemoral branched seta present in Bonziinae **8b** *Bonzia* **8c** *Parabonzia*.

Idiosoma, dorsal. proterosoma bears a shield complemented with 2 pairs of setae (*at* and *pt*) and 2 pairs of setose sensillae (*lps* and *mps*). The dorsal hysterosoma bears a shield that may be complemented with a variable number of setae depending on the extent of the shield. Setae c_1–h_1, c_2, f_2 and h_2 present, and are smooth or spiculate. Cupule *im* present laterad and caudally of e_1. Integument that does not bear shields or plates is striated.

Coxae I–II fused and coxae III–IV fused. Genital plates bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 4 pairs of setae present on the anal plates. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female *Bonzia* (modified from Smiley 1992)

1	Tibiae IV trichobothrium setose (Fig. 9a)	**2**
–	Tibiae IV trichobothrium smooth (Fig. 9b)	3
2 (1)	Hysterosomal shield with 2 pairs of setae; Germany	***B. sphagnicola* Willmann, 1939**
–	Hysterosomal shield with 3 pairs of setae; N. America, S. America, Europe (possibly cosmopolitan)	***B. halacaroides* Oudemans, 1927**
3 (1)	Dorsal setae spiculate (Figs 10a, 11a); New Zealand	***B. woodi* Smiley, 1992**
–	Dorsal setae smooth (Figs 10b, 11b); USA: Virginia, Ozark Highlands	***B. yunkeri* Smiley, 1992**



Figures 9–11. *Bonzia* key illustrations. **9a** Setose tibial trichobothrium **9b** Smooth tibial trichobothrium **10a** Spiculate dorsal setae **10b** Smooth dorsal setae **11a** Close up of a spiculate seta **11b** Close up of a smooth seta.

Parabonzia Smiley, 1975

Historical review. Atyeo (1958) described *Bonzia bdelliformis* from a tree hole in Tennessee, USA. Smiley (1975) erected *Parabonzia* for *B. bdelliformis*. Den Heyer (1975) erected *Cunabdella* for *C. marthae*. Den Heyer (1977b) synonymized *Cunabdella* with *Parabonzia* and described *P. athiasae*. Kuznetzov and Livshitz (1979) reported *Parabonzia* from Russia. Smiley (1992) described *P. mumai* from Florida, USA. Corpuz-Raros (1996a) described *P. mindanensis* from the Philippines. Lin and Zhang (1998) described *P. trioxys*. Later they (Lin and Zhang 2002) described *P. zhangi*. Skvarla et al. (2013) reported *Parabonzia bdelliformis* from the Ozark Mountains in Arkansas.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. Apophyses absent. A multi-branched seta present dorsally on the telofemora. Tibiotarsi terminate in two strong setae. 2 pairs of adoral setae present or absent. **Subcapitulum** with up to 8 pairs of setae present.

Idiosoma, dorsal. Proterosoma bears a shield complemented with 2 pairs of setae (*at* and *pt*) and 2 pairs of setose sensillae (*lps* and *mps*). Dorsal hysterosoma may bear a shield; if a shield is present it may be complemented with a variable number of setae depending on the extent of the shield. Setae c_1–h_1, c_2, f_2 and h_2 present and smooth. Cupule *im* is present laterad and caudally of e_1. Integument that does not bear shields or plates is striated.

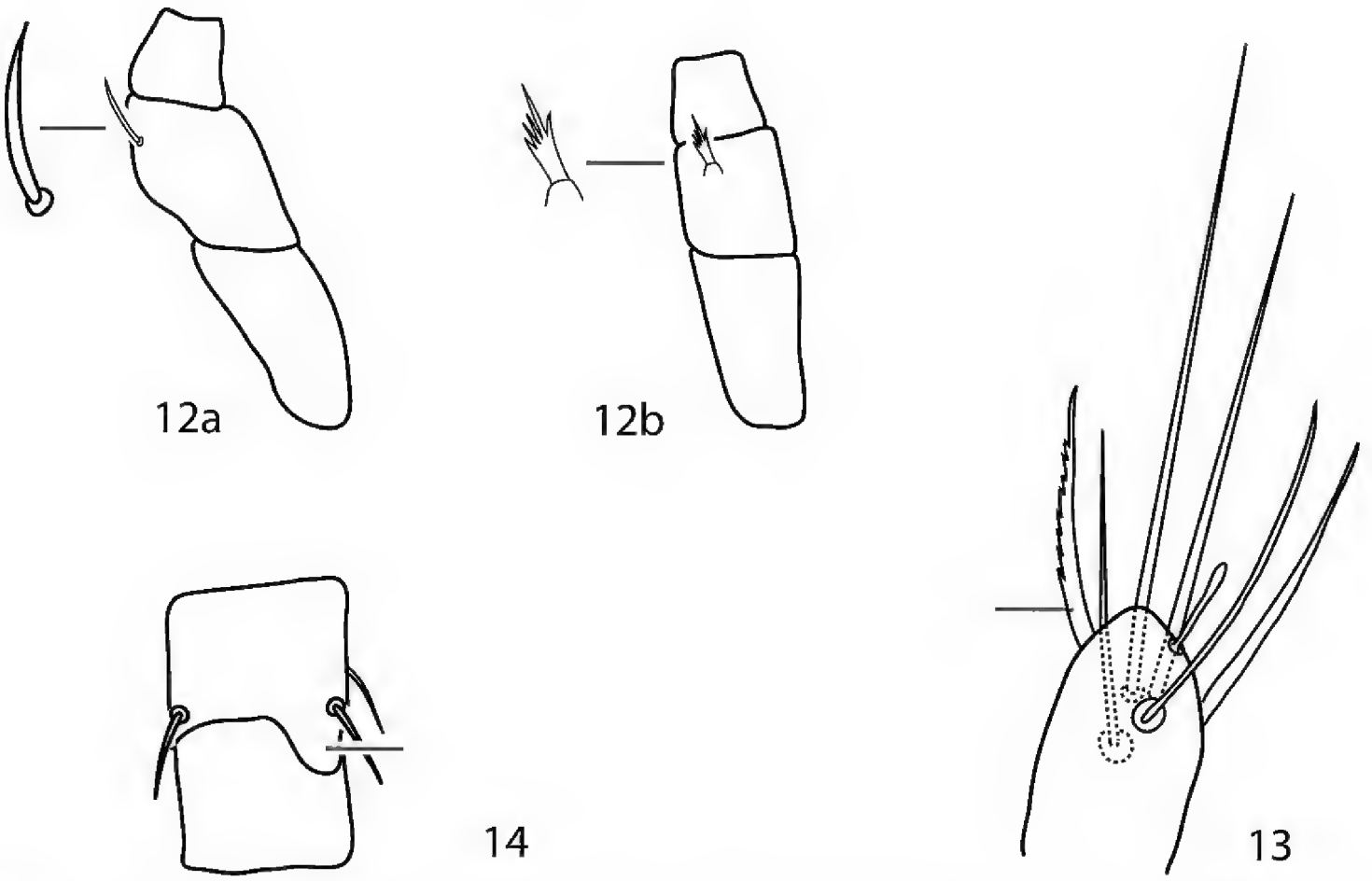
Idiosoma, ventral. **Coxae** I–II fused or not and coxae III–IV fused or not. Genital plates with up to 9 pairs of setae; 2 pairs of genital papillae visible underneath the plates. Up to 4 pairs of setae present on the anal plates. Up to 9 pairs of setae on the integument between coxae II and the anal plates. **Legs.** Trichobothrium on leg tibia IV present. The ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female *Parabonzia*

1	8–9 genital setae present **2**
–	6–7 genital setae present **3**
2 (1)	Pedipalpal telofemoral seta unbranched (Fig. 12a); Philippines, Mindanao Is ..... ***P. mindanensis* Corpuz-Raros, 1996**
–	Pedipalpal telofemoral seta branched, with 4–5 tines (Fig. 12b); China: Hubei Province..... ***P. zhangi* Lin & Zhang, 2002**
3 (1)	Hysterosomal shield with 3 pairs of setae **4**
–	Hysterosomal shield with 4 pairs of setae **6**
4 (3)	Pedipalpal tibiotarsal sigmoid setae lightly barbed (Fig. 13); South Africa: West Transvaal ..... ***P. marthae* (Den Heyer, 1975)**
–	Pedipalpal tibiotarsal sigmoid setae smooth **5**
5 (4)	Large spur-like process present on femora III (Fig. 14); USA: Florida..... ..... ***P. mumai* Smiley, 1992**
–	Large spur-like process absent on femora III; Ivory Coast .... ***P. athiasae* Den Heyer, 1977**
6 (3)	Coxae I–IV setal formula 7-5-6-7 sts; basifemora I–IV setal formula 4-7-3-2 sts; China: Fujian..... ***P. trioxys* Lin & Zhang, 1998**
–	Coxae I–IV setal formula 6-6 (sometimes 7)-7-7 sts; basifemora I–IV setal formula 5-8-3-2 sts; USA, Russia..... ***P. bdelliformis* (Atyeo, 1958)**

Cunaxoidinae Den Heyer, 1978

Historical review. Koch (1838) established *Eupalus* and described the first mite belonging to Cunaxoidinae, *Eupalus croceus*. Baker and Hoffmann (1948) proposed *Cunaxoides* to replace *Eupalus* Koch as the name was preoccupied (a fact that acarolo-



Figures 12–14. *Parabonzia* key illustrations. **12a** Unbranched pedipalp telofemoral seta **12b** Multi-branched pedipalp telofemoral seta **13** Lightly barbed pedipalp tibiotarsal sigmoid seta **14** Spur-like process on femora III.

gists had missed for 100 years) by *Eupalus* Gistl; they also redescribed and reillustrated a number of known species. Radford (1950) proposed *Haleupalus* to replace *Eupalus*, though this name is invalid because it is predated by *Cunaxoides*. Smiley (1975) erected *Neocunaxoides* and reviewed *Cunaxoides*. Both genera were assigned to the newly established Cunaxoidinae by Den Heyer (1978c). *Pulaeus* was established by Den Heyer (1979b); the name is an anagram and nod to *Eupalus*. Den Heyer (1979c) erected *Scutopalus* for those cunaxoidines with well-demarcated dorsal and ventral plates. Smiley (1992) synonymized *Scutopalus* with *Neocunaxoides* and *Haleupalus* with *Cunaxoides*; he also erected *Denheyernaxoides* and *Paracunaxoides* as monotypic genera in two new subfamilies, Denheyernaxoidinae and Paracunaxoidinae respectively. Castro and Den Heyer (2009) split a new genus, *Lupaeus*, from *Pulaeus* based on the number of setae on basifemora IV (1 and 2, respectively) and the number of pointed processes on the pedipalpal tibiotarsi (2 and 1, respectively). Den Heyer and Castro (2009) split *Bunaxella*, *Dunaxeus*, *Funaxopsis*, and *Qunaxella* from *Cunaxoides*; they also moved *Denheyernaxoides* and *Paracunaxoides* to Cunaxoidinae, thus disregarding Denheyernaxoidinae and Paracunaxoidinae as valid subfamilies.

Diagnosis. *Gnathosoma.* **Pedipalps** 3-segmented: a trochanter which lacks setae, fused femurogenu (femur + genu) which is complemented with 5 or 6 setae, and tibiotarsus (tibia + tarsus) which is complemented with 5 or 6 setae. Tibiotarsi may be complemented with a bladder- or bulb-like apophysis. Pedipalps do not reach beyond the subcapitulum by more than the distal half of the tibiotarsi. **Chelicera** with or with-

out seta near the cheliceral digit. **Subcapitulum** with 4 pairs of setae (hg_{1-4}) are present; setae hg_4 is often the longest. 2 pairs of adoral setae are present or absent.

Idiosoma, dorsal. Female with proterosomal shield (absent in *Cunaxoides ulcerosus*) which is complemented with two pairs of setae (*lps* and *mps*) and two pairs of setose sensillae (*at* and *pt*) and may bear a hysterosomal plate complemented with a varying number of setae; when present the dorsal hysterosomal plate may be fused with the proterosomal shield. Dorsal plates well demarcated or not. Dorsal setae c_1–h_1 are present; c_2, f_2 and h_2 may also be present. If f_2 is present, f_1 and f_2 may be located together on a small platelet. Setae not on larger plates may be born on small platelets barely larger than the setal socket. Cupule *im* present laterad and posterior of e_1. Integument that is not covered in shields or plates is striated

Idiosoma, ventral. **Coxae** of female vary in size, from being restricted to the trochantral bases to being extensive and nearly forming a holoventral shield. Coxae may or may not be well demarcated. Coxae I–II fused (usually) or not, coxae III–IV fused (usually) or not. Coxae I–II may coalesce medially to form a sternal shield. The genital plates each bear 4 setae (g_{1-4}); 2 pairs of genital papillae visible underneath the plates. The anal plates bear one pair of setae (ps_1); one pair of setae is present ventrally on the integument near the anal plates (either ps_2 or *pa*). Cupule *ih* is present ventrally laterad the integumental setae associated with the anal plates. The integument that is not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

Key to adult female Cunaxoidinae (modified from Den Heyer and Castro 2009)

1	Pedipalpal tibiotarsi with 3 sts, 1 spls; New Zealand ..... ***Paracunaxoides*** **Smiley, 1992**
–	Pedipalpal tibiotarsi with 5 or 6 sts, 0 spls **2**
2 (1)	Pedipalpal femurogenu with 5 setae; long setae ending in terminal bulb-like knob (very small) on tarsi III and IV present; telofemoral setal formula not 5-5-4-3; usually 6 setae on pedipalp tibiotarsus Cunaxoidini **3**
–	Pedipalpal femurogenu with 6 setae; long setae ending in terminal bulb-like knob (very small) on tarsi III and IV absent; telofemoral setal formula 5-5-4-3; usually 5 setae on pedipalp tibiotarsus Pulaeini **9**
3 (2)	Femora I and II divided; setae f_2 absent; trichobothrium on tibiae IV present or absent **4**
–	Femora I and II not divided; setae f_2 present; trichobothrium on tibiae IV absent ..... ***Denheyernaxoides*** **Smiley, 1992**
4 (3)	Dorsum with ill-defined weakly sclerotized dorsal plates (Fig. 15a); subterminal pointed process on pedipalp tibiotarsal claw present (Fig. 16a); small teeth (=serrated edge) on pedipalp tibiotarsal claw present (Fig. 16a); cheliceral setae absent **5**

– Dorsum with well-defined and sclerotized dorsal plates (Fig. 15b); subterminal pointed process on pedipalp tibiotarsal claw absent (Fig.16b); small teeth on pedipalp tibiotarsal claw absent (Fig. 16b); cheliceral setae present ..... ***Scutopalus* Den Heyer, 1979**

5 (4) Trichobothrium on tibiae IV present; famulus present, on distal portion of tarsus I ..... ***Cunaxoides***

– Trichobothrium on tibiae IV absent; famulus present or absent..... **6**

6 (5) Tibiae III with 1 bsl, 3–5 sts; tibiae IV with 2 or 4 sts 7

– Tibiae III with 1 lts, 4 sts; tibiae IV with 1 lsts, 4 sts..... ***Dunaxeus* Den Heyer & Castro, 2009**

7 (6) Tibiae III with 1 bsl, 3–5 sts; tibiae IV with 1 lts, 2 sts ..... ***Funaxopsis* Den Heyer & Castro, 2009**

– Tibiae III with 1 bsl, 5 sts; tibiae IV setal formula not as above 8

8 (7) Tibiae IV with 1 lsts, 4 sts; famulus present..... ***Qunaxella* Den Heyer & Castro, 2009**

– Tibiae IV with 4 sts; famulus absent.... ***Bunaxella* Den Heyer & Castro, 2009**

9 (2) Setae f_2 present; basifemora I–IV setal formula 4-6-3-1 or 4-6-3-2..... **10**

– Setae f_2 absent; basifemora I–IV setal formula 3-5-2-0 (rarely with 3-5-2-1)..... ***Neocunaxoides* Smiley, 1975**

10 (9) Basifemora I–IV setal formula 4-6-3-2; pedipalp tibiotarsus with one pointed process (ventral) (Fig. 17a); famulus on proximal half of tarsus I; tibiae I–II with non-striated blunt solenidia ..... ***Pulaeus* Den Heyer, 1979**

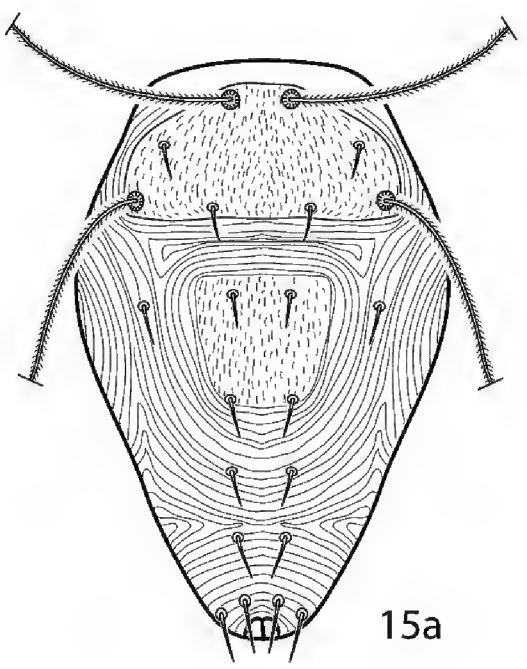
– Basifemora I–IV setal formula 4-6-3-1; pedipalp tibiotarsus with two pointed processes (1 ventral, 1 median) (Fig. 17b); famulus on distal half (subapical) of tarsus I; tibiae I–II with transversely striated blunt solenidia ..... ***Lupaeus* Castro & Den Heyer, 2009**

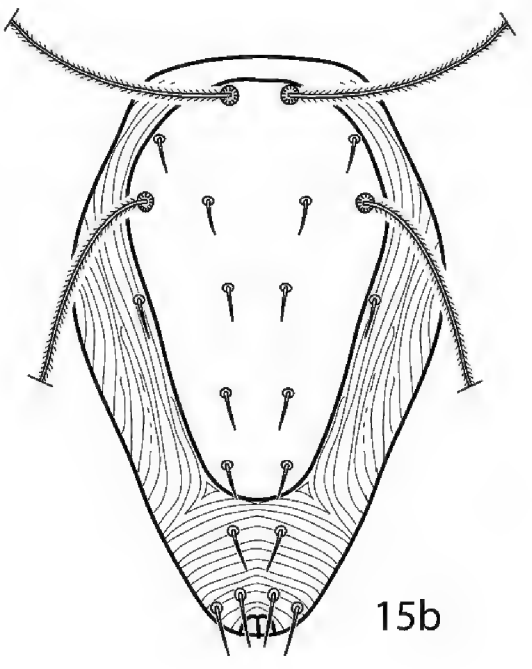
Bunaxella Den Heyer & Castro, 2009

Historical review. Den Heyer (1981b) described *Cunaxoides oribensis*, *C. quini*, and *C. zebedielensis*. Den Heyer and Castro (2009) erected *Bunaxella* and transferred *Cunaxoides oribensis*, *C. quini*, and *C. zebedielensis* to the new genus.

Diagnosis. *Gnathosoma.* **Pedipalps** 3-segmented. Femurogenua are at least twice as long as wide and complemented with 5 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. A small apophysis present basally and a pointed process occurs near the terminal tip; a ridge present between the apophysis and pointed process. **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae) present; setae hg_4 is often the longest. **Chelicera** without seta.

Idiosoma, *dorsal.* Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). The dorsal hysterosoma may or may not bear a plate; if a plate is present it


15a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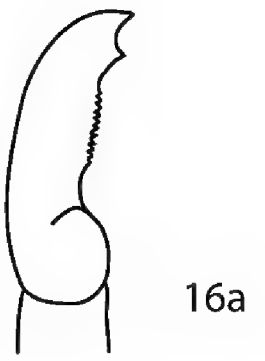
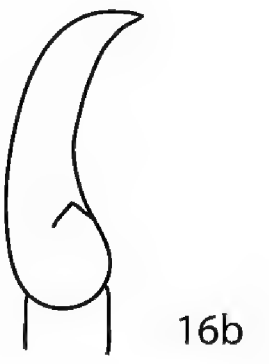

16a


16b

17a

17b

Figures 15–17. Cunaxoidinae key illustrations. Setae are removed from figures **16–17** for clarity **15a** Idiosoma with poorly demarcated dorsal plates **15b** Idiosoma with well demarcated dorsal plates **16a** Pedipalp tibiotarsus with subapical process and small teeth present **16b** Pedipalp tibiotarsus with subapical process and small teeth absent **17a** Pedipalp tibiotarsus with a single pointed process **17b** Pedipalp tibiotarsus with two pointed processes.

is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae c_1–h_1, c_2, and h_2 are present. Seta c_2 plumose or fan-shaped. Cupule *im* is present laterad and posterior of e_1. Integument that is not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** are weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV fused or not. Each coxa complemented with 2-4 setae. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae is present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. Integument that is not covered in shields or plates is striated. **Legs.** Tarsi are never constricted apically so as to end in lobes. Depression for the famulus on tarsus I is absent. Tibia III complemented with 1 bsl, 5 sts. Tibia IV is complemented with 4 sts and lacks a trichobothrium. Ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female *Bunaxella* (modified from Den Heyer and Castro 2009)

1	Basifemora I–IV with 3-3-3-0 sts; telofemora IV with 1 sts; dorsal setae fan-shaped, except for smooth f_2 ..... ***B. quini*** **(Den Heyer, 1981)**
–	Basifemora I–IV with 4-4-3-1 sts; telofemora IV with 2 sts; dorsal setae plumose, except for h_2 which may be plumose or smooth **2**
2 (1)	Setae h_2 plumose ..... ***B. oribensis*** **(Den Heyer, 1981)**
–	Setae h_2 smooth ..... ***B. zebedielensis*** **(Den Heyer, 1981)**

Cunaxoides Baker & Hoffmann, 1948

Historical review. Koch (1838) described the first two *Cunaxoides* as *Eupalus croceus* and *E. minutissimus*. Koch (1841) described *E. vitellinus*. Trägårdh (1910) described *E. minima*. Ewing (1917) described *E. parvus* and its feeding on oyster-shell scale in the USA. Thor and Willmann (1941) redescribed and figured *E. croceus*, *E. minutissimus*, and *E. vitellinus*. Nesbitt (1946) described *E. biscutum*. Garman (1948) reported *E. biscutum* from apple trees in Connecticut. Baker and Hoffmann (1948) recognized that the name *Eupalus* was preoccupied and erected *Cunaxoides* to replace it; they transferred all known *Eupalus* to the new genus and figured each species. *Haleupalus oliveri* was described by Schruft (1971). Smiley (1975) synonymized *C. vitellinus* with *C. croceus* and provided a translation of Thor and Willmann's (1941) description of *C. croceus*. Den Heyer (1978c) placed *Cunaxoides* as the type genus in the newly erected Cunaxoidinae; he also redescribed the genus and redescribed and designated a neotype for *C. croceus*. Kuznetzov and Livshitz (1979) described *C. ulcerosus*, *C. longistriatus*, *C. fidus* and *C. desertus* and reported and figured *C. biscutum*, and *C. parvus* from Russia. Gupta and Ghosh (1980) described *C. nicobarensis*. *C. kielczewskii* was described by Michocka (1982). Smiley (1992) synonymized *Haleupalus oliveri* with *C. biscutum*, effectively synonymizing *Haleupalus* with *Cunaxoides*. Hu (1997) reported *C. croceus* and *C. ulcerosus* from China. Sionti and Papadoulis (2003) described *C. paracroceus* from Greece. Bashir and Afzal (2004a) described *C. trisetosis*. Bashir et al. (2007) described *C. sargodhaensis* from Pakistan. Bashir and Afzal (2009) described *C. daskaensis*, *C. negans*, and *C. sialkotensis* Den Heyer et al. (2013) described *C. decastroae* and *C. lootsi*.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide and complemented with 5 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. A small apophysis present basally and a pointed process present near the terminal tip; a ridge present between the apophysis and pointed process. **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae) are present; setae hg_4 longest. **Chelicera** without seta.

Idiosoma, *dorsal*. Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). The dorsal hysterosoma may or may not bear a plate; if a plate is present it is ill-defined and weakly sclerotized, may be complemented with a variable number of

setae, and may or may not be fused with the proterosomal shield. Setae c_1–h_1, c_2, and h_2 are present. Cupule *im* present laterad and posterior of e_1. Integument that is not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa is complemented with 2-4 setae. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. Integument that is not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium present on leg tibia IV. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Cunaxoides*

The following species have not been included because the original descriptions and subsequent papers describing them (Thor and Willmann 1941; Baker and Hoffmann 1948) are not in English; known illustrations do not contain enough detail; and the types were not examined: *C. minima* (Trägårdh, 1910), *C. minutissimus* (Koch, 1938), *C. vitellinus* (Koch, 1941).

1	Dorsal hysterosomal median plate present (may be fused with proterosomal shield or only suggested by cuticular pattern) (Figs 18a–c, 19a–d, 20) **2**
–	Dorsal hysterosomal median plate absent (Figs 21a, b, 22) **9**
2 (1)	Hysterosomal median plate obvious, sclerotized (Figs 18a–d, 19a–c) **3**
–	Hysterosomal median plate not be obvious or sclerotized, may only be suggested by cuticular pattern (Fig. 20) **8**
3 (2)	Hysterosomal median plate not complemented with setae; USA..... ..... ***C. parvus*** **(Ewing, 1917)**
–	Hysterosomal median plate complemented with setae **4**
4 (3)	Hysterosomal median plate and proterosomal shield separate (Figs 18a–c) ... **5**
–	Hysterosomal median plate and proterosomal shield fused (Figs 19a–d) **6**
5 (4)	Hysterosomal median plate complemented with c_1, d_1 (Fig. 18a); Canada, USA..... ***C. biscutum*** **(Nesbitt, 1946)**
–	Hysterosomal median plate complemented with c_1, d_1, c_2 (Fig. 18b); Russia.. ..... ***C. fidus*** **Kuznetzov & Livshitz, 1979**
–	Hysterosomal median plate complemented with c_1–e_1, c_2 (Fig. 18c); Russia .. .. ***C. longistriatus*** **Kuznetzov & Livshitz (1979**
6 (4)	Hysterosomal shield complemented with setae c_1, d_1, c_2; (Figs 19a, b) 7

– Hysterosomal shield complemented with setae c_1- e_1, c_2; (Figs 19c) ..... ***C. decastroae*** **Den Heyer, 2013**

7 (6) Genua IV with 1 asl, 5 sts; striae between *sci* and c_1 U-shaped (Fig. 19a); Greece ..... ***C. paracroceus*** **Sionti & Papadoulis, 2013**

– Genua IV with 2 asl, 5 sts; striae between *sci* and c_1 parallel (Fig. 19b); Europe ..... ***C. croceus*** **(Koch, 1838)**

8 (2) Dorsal striae form one "shield-like" area, similar to fused proterosomal and hysterosomal shield (Fig. 23a); Poland..... ***C. kielczewskii*** **Gupta & Ghosh, 1980**

– Dorsal striae form two "shield-like" areas, similar to separate proterosomal and hysterosomal shields (Fig. 23b); Iran..... ***C. lootsi*** **Den Heyer, 2013**

9 (1) Proterosomal shield present (Figs 21a, b) **10**

– Proterosomal shield absent (Fig. 22); Russia ..... ***C. ulcerosus*** **Kuznetzov & Livshitz (1979**

10 (9) Dorsal shield reticulated (Fig. 21a); Russia ..... ***C. desertus*** **Kuznetzov & Livshitz (1979**

– Dorsal shield striated (Fig. 21b)..... **11**

11 (10) Telofemora I–III setal formula 4-3-3; India ..... ***C. nicobarensis*** **Gupta & Ghosh, 1980**

– Telofemora I–III setal formula 5-5-4 or 5-5-6 ..... **12**

12 (11) Telofemur III with 3 sts; Pakistan..... ***C. sialkotensis*** **Bashir & Afzal, 2009**

– Telofemur III with 4 sts..... **13**

– Telofemur III with 6 sts; Pakistan..... ***C. negans*** **Bashir & Afzal, 2009**

13 (12) Basifemur I with 1 sts **14**

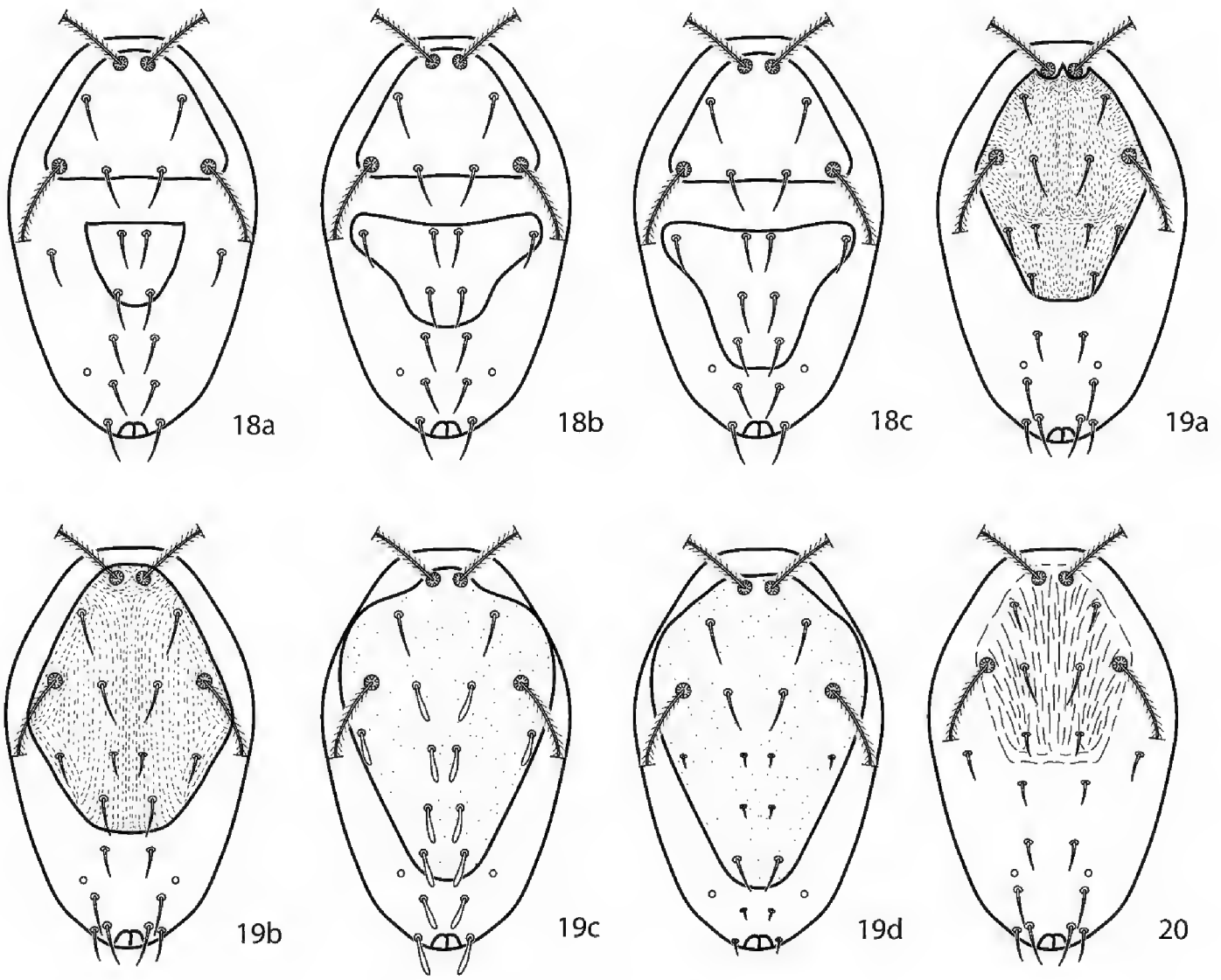
– Basifemur I with 2 sts; Pakistan ..... ***C. daskaensis*** **Bashir & Afzal, 2009**

14 (13) Basifemora II–IV setal formula 1-1-0; Pakistan..... ***C. trisetosis*** **Bashir & Afzal, 2004**

– Basifemora II–IV setal formula 4-2-0; Pakistan..... ***C. sargodhaensis*** **Bashir, Afzal & Raza, 2007**

Denheyernaxoides **Smiley, 1992**

Historical review. Canestrini (1885) described *Eupalus brevirostris*. Berlese (1894, 1897) redescribed *E. brevirostris* and provided illustrations of the dorsal idiosoma, chelicera, and palp. Baker and Hoffmann (1948) proposed *Cunaxoides* as *nomen novum* as *Eupalus* was preoccupied. Smiley (1992) erected Denheyernaxoidinae and *Denheyernaxoides* for *D. martini*. Lin (2001) moved transferred *C. brevirostris* to *Denheyernaxoides* and redescribed the species based on specimens from China. Den Heyer (2009) considered Denheyernaxoidinae as a junior synonym of Cunaxoidinae. Den Heyer and Castro (2009) considered *Denheyernaxoides* to belong to Cunaxoidini. Sergeyenko (2011) reported *D. brevirostris* from Ukraine and erected Denheyernaxoidini for the genus.



Figures 18–23. *Cunaxoides* key illustrations. See key for explanations.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. **Subcapitulum** with 4 pairs of setae ($hg_{1–4}$); setae hg_4 often the longest. Adoral setae absent. **Chelicera** without seta.

Idiosoma, dorsal. Proterosoma lacks a shield, complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma lacks a

plate. Setae c_1–h_1, c_2, and f_2, h_2 present. Cupule *im* present laterad and posterior of e_1. Integument not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** I–II connected by small apodemes. Coxae III–IV fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. 5 pairs of setae present on the integument between the coxal and genital plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated. **Legs.** Femora I and II not divided. Trichobothrium on tibia IV absent. Tarsi never constricted apically so as to end in lobes. Ambulacral claws on either side of a 4-rayed empodium present.

Key to adult female *Denheyernaxoides*

1 Coxa I with 1 sts; trochanters I–IV setal count 1-1-1-1; femora I-II setal count 2–2; gnathosoma with deep indention posterioventrally ..... ***D. martini* Smiley, 1992**

– Coxa I with 3 sts; trochanters I–IV setal count 0-0-1-0; femora I-II setal count 4–5; gnathosoma with slight indention posterioventrally ..... ***D. brevirostris* (Canestrini 1885)**

Dunaxeus Den Heyer & Castro, 2009

Historical review. Den Heyer (1981b) described *Cunaxoides capensis* and *C. elongatus*. Den Heyer and Castro (2009) erected *Dunaxeus*, transferred *D. capensis* and *D. elongatus* to the genus, and described *D. duosetosus*.

Diagnosis. *Gnathosoma.* **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. **Subcapitulum** with 4 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae); setae hg_4 is often the longest. **Chelicera** without seta.

Idiosoma, dorsal. Proterosoma bears an ill-defined and weakly sclerotized shield which is complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma may or may not bear a plate; if a plate is present it is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae c_1–h_1, c_2, and h_2 are present. Cupule *im* is present laterad and posterior of e_1. The integument that is not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV fused. Each coxa

complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae visible underneath plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Tibia III complemented with 5 sts (4 short, 1 long). Tibia IV complemented with 5 sts (4 short, 1 long), and lacks a trichobothrium. Ambulacral claws on either side of a 4-rayed empodium present.

Key to adult female *Dunaxeus*

1	Basifemora IV with 1 sts	***D. elongatus* (Den Heyer, 1981)**
–	Basifemora IV with 2 sts	**2**
2 (1)	Famulus on tarsus I present	***D. capensis* (Den Heyer, 1981)**
–	Famulus on tarsus I absent	***D. duosetosus* Den Heyer & Castro, 2009**

Funaxopsis Den Heyer & Castro, 2009

Historical review. Den Heyer (1981b) described *Cunaxoides passerinae*, *C. vaneedeni*, and *C. visci*. Den Heyer and Castro (2009) erected *Funaxopsis* and transferred *F. passerinae*, *F. vaneedeni*, and *F. visci* to the genus.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 5 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae. A small apophysis occurs basally and a pointed process occurs near the terminal tip; a ridge runs between the apophysis and pointed process. **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae); setae hg_4 is often longest. **Chelicera** without seta.

Idiosoma, dorsal. Proterosoma bears an ill-defined and weakly sclerotized shield complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma may or may not bear a plate; if plate present, it is ill-defined and weakly sclerotized, may be complemented with a variable number of setae, and may or may not be fused with the proterosomal shield. Setae c_1–h_1, c_2, and h_2 present. Cupule *im* present laterad and posterior e_1. Integument not covered in shields or plates striated.

Idiosoma, ventral. **Coxae** weakly sclerotized and ill-defined; they can be recognized by possessing somewhat denser striations than the surrounding integument. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Up to 7 pairs of setae present on the integument between the coxal and genital plates. Cupule *ih* present ventrally laterad integumental setae associated with the anal plates. Integument not covered in shields or plates striated. **Legs.** Tibia III complemented with 1 bsl and 3, 4, or 5 sts. Tibia IV complemented with 3 sts (2 short, 1 long) and lacks

a trichobothrium. Tarsi never constricted apically so as to end in lobes. Ambulacral claws on either side of a 4-rayed empodium present.

Key to adult female *Funaxopsis* (modified from Den Heyer and Castro 2009)

1	Basifemora I–IV setal formula 3-3-3-1 sts; *sci* smooth..... ..... ***F. visci* (Den Heyer, 1981)**
–	Basifemora I–IV setal formula 2-2-2-0 sts; *sci* finely setose.....**2**
2 (1)	Telofemora I–IV setal formula 4-3-1-1 sts; h_1 smooth .... ***F. passerinae* (Den Heyer, 1981)**
–	Telofemora I–IV setal formula 4-4-3-1 sts; h_1 finely setose .... ***F. vaneedeni* (Den Heyer, 1981)**

Lupaeus Castro & Den Heyer, 2009

Historical review. Berlese (1916) described *Eupalus subterraneus*. Thor and Willmann (1941) redescribed *E. subterraneus*. Baker and Hoffmann (1948) erected *Cunaxoides* in place of *Eupalus* as *Eupalus* was preoccupied; they also described *C. minutus* and redescribed and illustrated *C. subterraneus*. Den Heyer (1979b) erected *Pulaeus*, moving those species with f_2 present and setae present on basifemora IV to the new genus from *Cunaxoides*; he also described *P. martini* and *P. clarae* and placed *Pulaeus* into the subfamily Cunaxoidinae. *Pulaeus platygnathus* was described by Bu and Li (1991). Corpuz-Raros (1996b) described *P. dentatus*, *P. lenis*, *P. longisetus*, *P. villacarlosae*, and *P. filipinus* from the Philippines. Hu (1997) reported *P. platygnathus* from China. Lin and Zhang (2000) reported *P. platygnathus* from China. Lin and Zhang (2003) reported *P. minutus* from China. Corpuz-Raros (2007) described *P. polilloensis* and *P. philippinensis* from the Philippines. Castro and Den Heyer (2009) erected *Lupaeus* and moved into it those species of *Pulaeus* that possess two pointed processes on the pedipalp tibiotarsus and 1 simple seta on basifemora IV; they also described *Lupaeus lectus* and *L. lobidorsalis* and provided a key to the Brazilian and South African species. Sergeyenko (2011b) described *L. valentinae*. Den Heyer et al. (2013) described *L. iranensis* and *L. sativae*.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae; they possess 2 or 3 pointed processes and may possess a bladder- or knob-like apophysis (Fig. 24a). **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae); setae hg_4 often the longest. **Chelicera** with seta present.

Idiosoma, *dorsal*. Proterosoma bears a well-sclerotized shield complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma bears a sclerotized plate that is variable in size and fused with the proterosomal shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae c_1–h_1, c_2, f_2, and h_2 present. Cupule *im* present laterad and posterior of e_1. Integument not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** sclerotized and well-defined. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae (g_{1-4}). Setae $g_{1,2,4}$ usually occur in a straight line near the midline and setae g_3 occur near the edge of the genital plates (Fig. 24b). 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Cupule *ih* present ventrally laterad; the integumental setae associated with the anal plates. Integument not covered in shields or plates striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Basifemora setal formula 4-6-3-1. Depression of the famulus occurs on distal half of tarsus I. Tibiae I–II possess striated blunt solenidia. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Lupaeus*

Lupaeus longisetus is known only from the male and is not included in the key. It can be recognized by the following characters: small platelet between the edges of a divided sternal shield absent, basifemora I with 3 sts, and setae e_1 elongate and barbed (Fig. 25a).

Lupaeus polilloensis is only known from the male and is not included in the key. It can be recoginized by the following characters: small platelet between the edges of a divided sternal shield absent; basifemora I–II setal formula 4-6; platelets complemented with setae f_1, f_2 with fused medially into one plate; and the dorsal shield densely granulate (Fig. 25b).

As suggested by Den Heyer (2011b) the following species are moved to *Lupaeus* from *Pulaeus* : *L. minutus* (Baker and Hoffmann) and *L. subterraneus* (Berlese).

1		Small platelet ventromedially between edges of divided sternal plate present (Fig. 26a); South Africa, Brazil ..... ***L. martini* (Den Heyer, 1979)**
–		Small platelet ventromedially between edges of divided sternal plate absent (Fig. 26b)..... **2**
2 (1)		Basifemora I with 4 sts..... **3**
–		Basifemora I with 5 sts; Philippines ..... ***L. filipinus* (Corpuz-Raros, 1996)**
3 (2)		Basifemora II with 4 sts; USA..... ***L. minutus* (Baker & Hoffmann, 1948)**
–		Basifemora II with 5 sts **4**
–		Basifemora II with 6 sts 7
4 (3)		Setae f_1 shorter than c_1; Philippines ..... ***L. lenis* (Corpuz-Raros, 1996)**
–		Setae f_1 the same length as c_1 ..... ***L. lectus* Castro & Den Heyer, 2009**
–		Setae f_1 longer than c_1, usually by at least 1.5 times **5**
5 (4)		Genua I with 9 total simple setae and solenidia; Philippines ..... ***L. dentatus* (Corpuz-Raros, 1996)**
–		Genua I with 7 total simple setae and solenidia..... **6**

6 (5) Setae c_1–e_1 equal in length; Brazil ..... ***L. lobidorsalis* Castro & Den Heyer, 2009**

– Setae e_1 one-fourth longer than c_1,d_1; Italy, USA ..... ***L. subterraneus* (Berlese, 1916)**

7 (3) Setae f_1,f_2 on platelets, which may be separate or fused medially (Fig. 27a) **8**

– Setae f_1,f_2 on integument (Fig. 27b) **11**

8 (7) Tibia II with 1 s, 5 sts **9**

– Tibia II with 2 s (1 asl, 1 bsl), 5 sts; Ukraine.... ***L. valentinae* Sergeyenko, 2011**

9 (8) Pedipalp tibiotarsus with 4 sts; Philippines ..... ***L. villacarlosae* (Corpuz-Raros, 1996)**

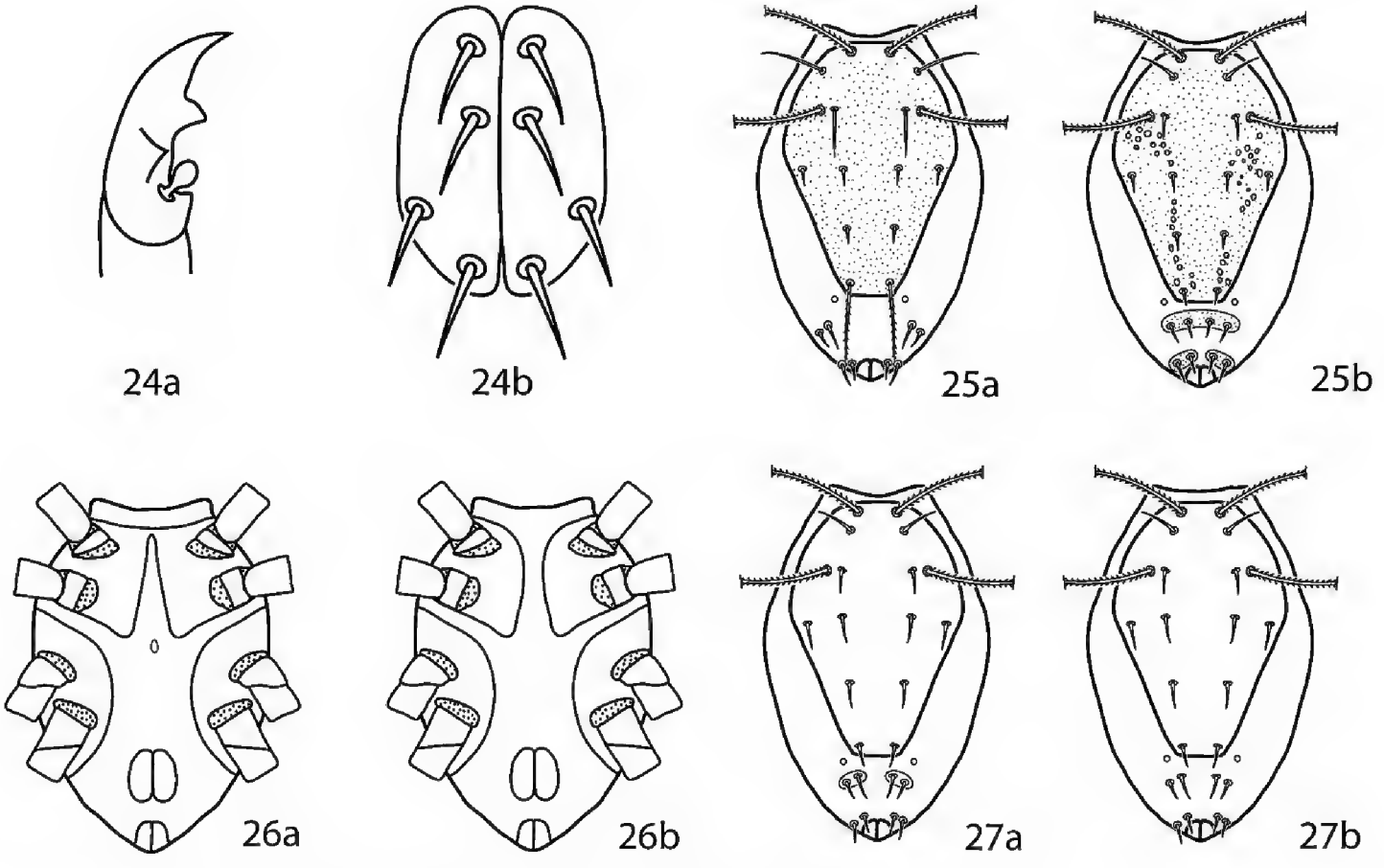
– Pedipalp tibiotarsus with 5 sts **10**

10 (9) Tarsus I with 3 asl, 2 terminal solenidion, 1 fam, 20 or 21 sts; tarsus IV with 14 sts ..... ***L. iranensis* Den Heyer, 2013**

– Tarsus I with 3 asl, 1 dorsodistal solenidion, 1 terminal solenidion, 1 fam, 22 sts; tarsus IV with 16 sts ..... ***L. sativae* Den Heyer, 2013**

11 (7) Cheliceral seta not as long as width of cheliceral digit; China..... ***L. platygnathus* (Bu & Li, 1991)**

– Cheliceral seta longer than width of cheliceral digit; South Africa, Brazil..... ***L. clarae* (Den Heyer, 1979)**



Figures 24–27. *Lupaeus* illustrations. **24a** Pedipalp tibiotarsus **24b** Genital setae not in a row, g_3 out of line **25–27** *Lupaeus* key illustrations. Setae and cupules removed from figures **25a, b** to increase clairity **25a** *L. longisetus*, dorsal **25b** *L. polilloensis*, dorsal **26a** Ventral, small platelet present **26b** Ventral, small platelet absent **27a** Setae f_1,f_2 born on small platelets **27b** Setae f_1,f_2 born on integument.

Neocunaxoides Smiley, 1975

Historical review. Baker and Hoffmann (1948) described *Cunaxoides andrei*. Smiley (1975) erected *Neocunaxoides* and moved *N. andrei* to the genus. Gupta and Chattopadhyay (1978) described *N. biswasi* from bird nests in Bengal, India. Den Heyer (1978c) placed *Neocunaxoides* in the subfamily Cunaxoidinae. Kuznetzov and Livshitz (1979) reported *C. andrei* from Russia, having either disagreed with or been unaware of Smiley's 1975 publication. Den Heyer (1980a) described *N. lajumensis*, *N. rykei*, and *N. zuluensis* from South Africa. Tseng (1980) reported and figured *N. andrei* and *N. whartoni* from Taiwan. Michocka (1987) reported *N. andrei* from Poland. Inayatullah and Shahid (1989) described *N. dilato* and *N. kalamiensis*. *N. cerasoides* was described by Gupta (1991). Smiley (1992) synonymized *Scutopalus* with *Neocunaxoides* and moved *Cunaxoides trepidus* to *Neocunaxoides*. Corpuz-Raros (1996c) described *N. grandis* and *N. mahabaeus*. Hu (1997) reported *N. andrei* from China. Lin, Zhang, and Ji (2001) described *N. boltoides* and *N. fani* and later (2003) described *N. ovatus*. Fawzy (2007) described *N. metwallyi*. Corpuz-Raros and Gruèzo (2007) described *N. ornatus*. Castro and Den Heyer (2009) moved *Pulaeus trepidus* (=*Neocunaxoides trepidus*) to *Scutopalus*.

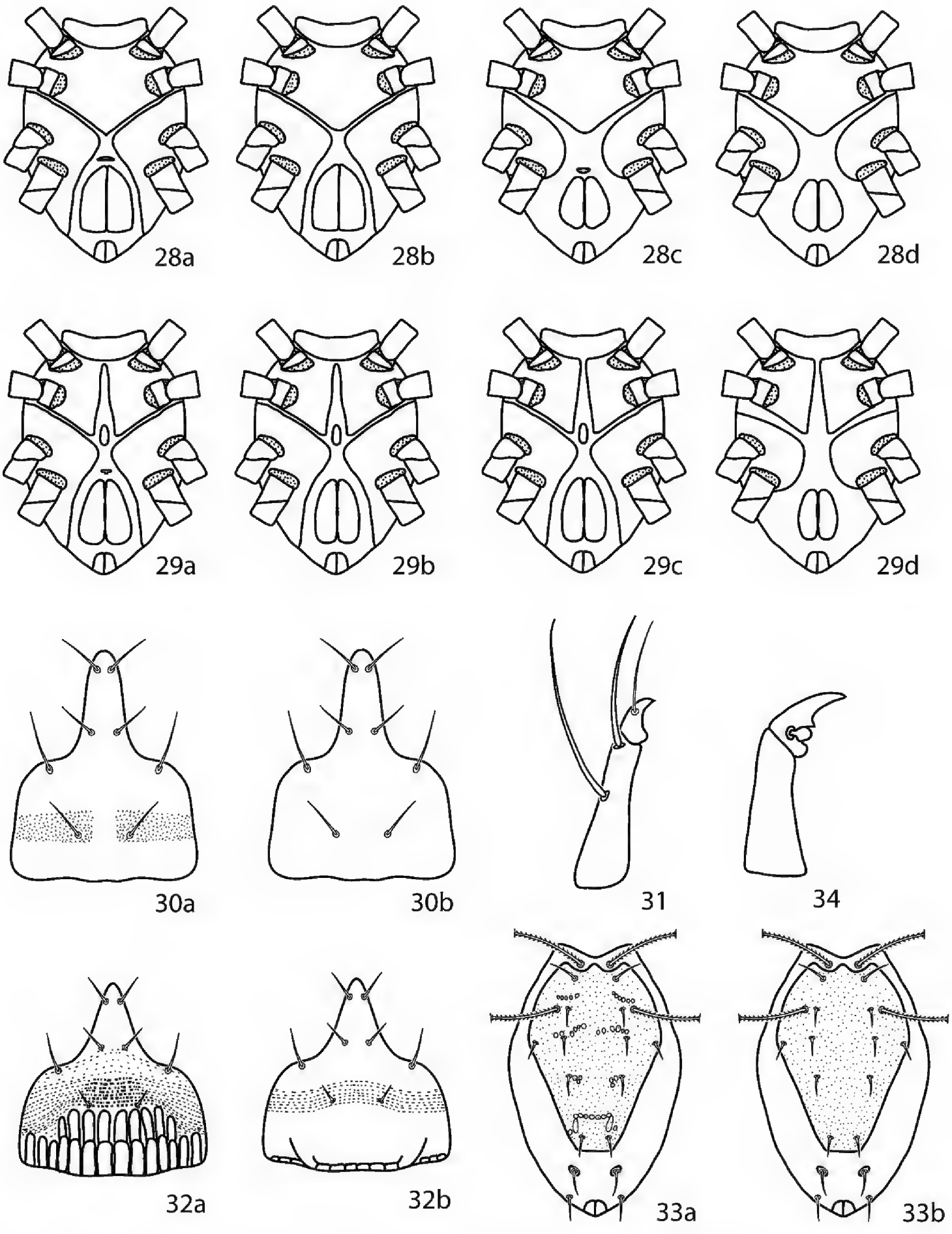
Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide and usually complemented with 6 setae. Tibiotarsi possess two or three knob-like apophyses, a single spur, or sometimes a flange-like seta. **Subcapitulum** with 6 pairs of setae (hg_{1-4} and 2 pairs of adoral setae); setae hg_4 often the longest. **Chelicera** with seta present.

Idiosoma, dorsal. Proterosoma bears a well-sclerotized shield which is complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma bears a sclerotized plate which is variable in size and fused with the proterosomal shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae c_1–h_1, c_2, and h_2 present. Setae f_2 absent. Cupule *im* present laterad and posterior of e_1. The integument not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** sclerotized and well-defined. Coxae I–II may be fused and may coalesce medially for form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae (g_{1-4}), which are usually in a straight now; 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; one pair of setae is present ventrally on the integument near the anal plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. Integument not covered in shields or plates is striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Basifemora setal formula 3-5-2-0. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Neocunaxoides*

Cunaxoides philippinensis (Corpuz-Raros, 2007) is regarded as belonging to *Neocunaxoides* because it has 6 seatae on the femurogenu and lacks setae f_2. *Neocunaxoides makapalus*, *N. philippinensis* (Corpuz-Raros, 1996c), *N. unguianalis*, and *N. rugosus* are



Figures 28–34. *Neocunaxoides* key illustrations. See key for explanations of figures.

regarded as belonging to *Scutopalus* as they possess 5 sts on pedipalp femurogenu and extensive dorsal shields. They have therefore not been included in the following key.

Neocunaxoides biramus is not included in the key because it is only known from the male. It can be distinguished from all other *Neocunaxoides*, and indeed all de-

scribed cunaxids, by the presence of a branched *sci* and 4 teeth on the lateral lips of the hypostome.

Neocunaxoides metwallyi is not included in the key as, despite the best efforts of the authors and the University of Arkansas Interlibrary Loan Department, the description could not be obtained.

We agree with and follow Castro and Den Heyer (2009) and Den Heyer and Castro (2009) in regarding *Scutopalus* as a valid and separate genus.

1	Coxae I–II fused medially to form sternal shield (Figs 28a–d)	**2**
–	Coxae I–II not fused medially (may be connected anteromedially) (Figs 29a–d)	**6**
2	(1) ..... Posterior edge of coxae IV extending beyond anterior edge of genital plates (Figs 28a, b)	**3**
–	Posterior edge of coxae IV not extending beyond anterior edge of genital plates (Figs 28c, d)	**5**
3 (2)	Small platelet anteriomedially of genital plates present (Fig. 28a)	***N. fani* Lin, Zhang & Ji, 2001**
–	Small platelet anteriomedially of genital plates absent (Fig. 28b)	**4**
4 (3)	Solid or broken band of papillae on ventral subcapitulum present (Fig. 30a); subcapitulum longer, length: width 1.75:1	***N. zuluensis* Den Heyer, 1980**
–	Solid or broken band of papillae on ventral subcapitulum absent (Fig. 30b); subcapitulum shorter, length: width 1.25:1	***N. lajumensis* Den Heyer, 1980**
5 (2)	Hysterosomal plate present, fused with proterosomal shield, and bearing c_1–e_1, c_2; small platelet anteriomedially of genital plates present (Fig. 28c)	***N. boltoides* Lin, Zhang & Ji, 2001**
–	Hysterosomal plate absent; small platelet anteriomedially of genital plates absent (Fig. 28d)	***N. philippinensis* (Corpuz-Raros, 2007)**
6 (1)	Median platelet between coxae II present (Figs 29a–c)	**7**
–	Median platelet between coxae II absent (Fig. 29d)	**13**
7 (6)	Basifemora V with 1 sts	**8**
–	Basifemora V with 0 sts	**11**
8 (7)	Basifemora I with 2 sts.....	***N. biswasi* Gupta & Chattopadhyay, 1978**
–	Basifemora I with 3 sts	**9**
9 (8)	All setae on pedipalp of normal length, none extremely long	**10**
–	2 setae on pedipalp femurogenu extremely long, nearly as long as segment; 1 distal pedipalp tibiotarsal setalong, longer than segment (Fig. 31).....	***N. mahabaeus* Corpuz-Raros, 1996**
10 (9)	Basal subcapitular polygonal pattern elongate (Fig. 32a); foveolae on dorsal shield present (Fig. 33a).....	***N. ornatus* Corpuz-Raros & Gruèzo, 2007**
–	Basal subcapitular polygonal pattern not elongate (Fig. 32b); foveolae on dorsal shield absent (Fig. 33b).....	***N. grandis* Corpuz-Raros, 1996**

11 (7) Small platelet anteriomedially of genital plates present (Fig. 29a) ..... ***N. ovatus* Lin, Zhang & Ji, 2003**

– Small platelet anteriomedially of genital plates absent (Fig. 29b,c) **12**

12 (11) Coxae I connected anteromedially (Fig. 29b); mushroom-shaped seta on pedipalp tibiotarsi absent ..... ***N. rykei* Den Heyer, 1980**

– Coxae I not connected anteromedially (Fig. 29c); mushroom-shaped seta on pedipalp tibiotarsi present (Fig. 34) ..... ***N. andrei* (Baker & Hoffmann, 1948)**

13 (6) Femora I (basifemora I + telofemora I) with 6 setae ..... ***N. cerasoides* Inayatullah & Shahid, 1989**

– Femora I (basifemora I + telofemora I) with 9 setae **15**

14 (13) Coxae I-IV setal formula 2-3-3-1; combined femora (basifemora + telofemora) II-IV setal formula 11-7-5 ..... ***N. dilato* Inayatullah & Shahid, 1989**

– Coxae I-IV setal formula 2-2-3-2; combined femora (basifemora + telofemora) II-IV setal formula 10-7-4 ..... ***N. kalamiensis* Inayatullah & Shahid, 1989**

Paracunaxoides Smiley, 1992

Historical review. Smiley (1992) erected *Paracunaxoides* for a single species, *P. newzealandicus*. Den Heyer and Castro (2009) state that *Paracunaxoides* could be synonymous with *Cunaxoides* but refrained from sinking the genus as they had not examined the type material.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femerogenu complimented with 5 setae. Tibiotarsi at least twice as long as wide and complemented with 3 setae. Tibiotarsi possess a stout, spine-like apophysis. **Subcapitulum** with 4 pairs of setae (hg_{1-4}); setae hg_{2-4} subequal. Adoral setae absent.

Idiosoma, dorsal. Proterosoma complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). A pair of oval shields formed by flat, bacillus-like striae present between the sensillae. Setae c_1–h_1, c_2, and h_2 present. Setae f_2 absent. Integument not covered in shields or plates is striated.

Idiosoma, ventral. **Coxae** sclerotized and well-defined. Coxae I–II thinly connected. Coxae III–IV more broadly connected. Genital plates each bear 4 setae (g_{1-4}); 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Integument not covered in shields or plates is striated. **Legs.** Trichobothrium on tibia IV present.

Pulaeus Den Heyer, 1978

Historical review. Ewing (1909) described the first species of *Pulaeus* as *Eupalus pectinatus*. Berlese (1916) described *Eupalus sternalis*. Baker and Hoffmann (1948) proposed *Cunaxoides* to replace *Eupalus* as the name was preoccupied; described *Cunax-*

oides patzcuarensis, *C. whartoni*, and *C. americanus*; and synonymized *C. sternalis* with *C. pectinatus*. They also redescribed and illustrated *C. pectinatus*. Muma (1960) described *C. pectinellus*. Shiba (1978) described *C. neopectinatus*, *C. parapatzuarensis*, and *C. pseudominutus*. Chaudhri, Akbar, and Rasool (1979) described *Neocunaxoides krama*. Kuznetzov and Livshitz (1979) reported *C. pectinatus* and *C. americanus* from Russia. Den Heyer (1979b) erected *Pulaeus* and moved the previously mentioned species into the new genus; he also redescribed *P. pectinatus* and described *P. glebulentus*. *Neocunaxoides cinctus* was described by Chaudhri (1980). Den Heyer (1981c) confirmed the synonymy of *P. sternalis* with *P. pectinatus*, and synonymized *C. pectinellus* with *P. pectinatus*; he also described *P. franciscae* and placed *Pulaeus* within Cunaxoidinae, tribe Pulaeini. El-Bishlawy and Rakha (1983) described *P. zaherii* from Egypt. Liang (1983) reported *P. pseudominutus* from China. *Pulaeus musci* was described by Liang (1985). Zaher and El-Bishlawy (1986) described *P. niloticus*. Bu and Li (1987b) described *P. longignathos* and *P. chongqingensis*. Muhammad and Chaudhri (1990) described *P. desitis*, *P. ferventis*, *P. osculum*, and *P. verno* from Pakistan. *Pulaeus ardeola* was described by Barilo (1991). Muhammad and Chaudhri (1991a) described *P. camar*, *P. erinaceus*, *P. galumma*, *P. haurio*, *P. silicula*, and *P. stultus* from Pakistan. Smiley (1992) synonymized *P. niloticus* with *P. subterraneus* and provided a key to known world species; he also transferred *Cunaxoides neopectinatus* to *Neocunaxoides*. Li et al. (1992) recorded *P. glebulentus* from Chongqing, China. Corpuz-Raros (1996b) described two species, *P. payatopalpus* and *P. rimandoi*, from the Philippines. Lin and Zhang (2000) reported *Neocunaxoides neopectinatus*, *Pulaeus longignathos*, *P. musci*, and *P. pseudominutus* from China. Lin et al. (2003) reported *P. minutus* from China. Bashir, Afzal, and Akbar (2005) described *P. punctatus*. Bashir and Afzal (2006b) described *P. anjumi*. Corpuz-Raros (2007) also described *P. cebuensis*, *P. palawanensis*, and *P. samarensis*. Castro and Den Heyer (2009) split *Lupaeus* from *Pulaeus* and described two new species: *P. myrtaceus* and *P. quadrisolenidius*; they also synonymized *P. longignathos* with *Neocunaxoides krama* and transferred *N. krama* to *Pulaeus*. Bashir and Afzal (2009) described *P. akbari*, *P. banksi*, and *P. walii*. Lin and Zhang (2010) argue that the "original species name *longignathos* [as in *Pulaeus longignathos*] is the correct form in Greek. Some authors emended it to the Latinized form *longignathus* (e.g. Castro and Den Heyer, 2009: 2)." The spelling *longignathos* is followed here. Sergeyenko (2011b) described *P. leonidi*, *P. maslovi*, and *P. semistriatus* and synonymized *P. longignathos* and *P. chongqingensis* with *P. krama* as he considered them to be male and female of that species, respectively. Den Heyer et al. (2013) described *P. razanensis*.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenua at least twice as long as wide, complemented with 6 setae. Tibiotarsi at least twice as long as wide, usually complemented with 6 setae, 1 pointed process, and may possess a bladder- or knob-like apophysis (Fig. 39a–c). **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae); setae hg_4 often the longest. **Chelicera** with seta present.

Idiosoma, *dorsal*. Proterosoma bears a well-sclerotized shield, complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma bears a sclerotized plate which is variable in size and fused with the proterosomal

shield; it may be complemented with a variable number of setae depending on the size of the plate. Setae c_1–h_1, c_2, f_2, and h_2 and present. Cupule *im* present laterad and posterior of e_1. Integument not covered in shields or plates striated.

Idiosoma, ventral. **Coxae** sclerotized and well-defined. Coxae I–II may be fused and may coalesce medially to form a sternal shield. Coxae III–IV may be fused. Each coxa complemented with 2–4 setae. Genital plates each bear 4 setae ($g_{1–4}$), which are usually in a straight row; 2 pairs of genital papillae visible underneath the plates. Anal plates bear one pair of setae; 1 pair of setae present ventrally on the integument near the anal plates. Cupule *ih* present ventrally laterad the integumental setae associated with the anal plates. The integument not covered in shields or plates striated. **Legs.** Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Depression of the famulus occurs on proximal half of tarsus I. Tibiae I–II possess non-striated blunt solenidia. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Pulaeus*

P. ardeola was not included in the key because the original text is in Cyrillic script and the illustrations do not provide enough characters to differentiate it from other species. *N. cinctus* is moved from *Neocunaxoides* to *Pulaeus* based on features given in the original description, namely that f_2 is present and basifemora IV are complemented with 2 sts.

The following were species assigned to *Pulaeus* before *Lupaeus* was erected. The characters that divide the two genera are not given in the original species descriptions and types have not been viewed. These indeterminable species are therefore not included in either generic key, but instead characters are given for each species that will serve to identify them.

P. parapatzuarensis (Shiba, 1978) – This species has a divided sternal plate, lacks a sclerotized area anterior to the genital plates, and does not have $f_{1,2}$ located on platelets. In addition it has 6 pairs of setae on the integument between coxal and genital plates.

P. patzcuarensis (Baker & Hoffmann, 1948) – This species can be recognized by the sternal plates being connected anteriorly and divided in a v-shape posteriorly.

P. pseudominutus (Shiba, 1978) – Setae e_1 being 3 times the length of c_1 and d_1 distinguishes this species.

P. payatopalpus (Corpuz-Raros, 1996) – The hypostome is 2/3 the length of the gnathosoma and the pedipalps are extremely long and slender, at least 8 times longer than wide. In addition the tibiotarsus is complemented with a seta that is longer than the segment.

P. zaherii (El-Bishlawy & Rakha, 1983) – This species can be recognized by the divided sternal plates, f_1 being 4/5 the length of e_1, and f_1 being ½ the length of f_2.

1	Sternal plate divided medially (Fig. 35a, b)	**2**
–	Sternal plate not divided medially (Fig. 36a, b)	**23**
2 (1)	Median platelet between coxae II–III present (Fig. 35a)	**3**
–	Median platelet between coxae II–III absent (Fig. 35b)	7

3 (2) Dorsal shield with surface smooth anteriorly and broken striae or lobes posteriorly; Ukraine ..... ***P. semistriatus*** **Sergeyenko, 2011**

– Dorsal shield with surface patterned (broken striae/lobes or dotted) on entire surface **4**

4 (3) Dorsal shield patterend with dots; Pakistan ..... ***P. punctatus*** **Bashir, Afzal & Akbar, 2005**

– Dorsal shield patterned with broken striae/lobes **5**

5 (4) Genua II with solenidia present **6**

– Genua II with solenidia absent; Pakistan..... ***P. banksi*** **Bashir & Afzal, 2009**

6 (5) Genua II with 1 asl, 5 sts; genua III with 2 asl, 5 sts; South Africa..... ***P. glebulentus*** **Den Heyer, 1979**

– Genua II with 2 asl, 4 sts; genua III with 1 asl, 5 sts; Iran ..... ***P. razanensis*** **Den Heyer, 2013**

7 (2) Setae f_1 and f_2 located on sclerotized platelets or shields..... **8**

– Setae f_1 and f_2 not located on sclerotized platelets or shields **20**

8 (7) Pedipalp femurogenu at least 6 times as long as wide; Philippines..... ***P. rimandoi*** **Corpuz-Raros, 1996**

– Pedipalp femurogenu at most 4 times as long as wide **9**

9 (8) Genua II with 0 solenidia; Pakistan **10**

– Genua II with 1 solenidion **12**

– Genua II with 2 solenidia; Philippines ..... ***P. samarensis*** **Corpuz-Raros, 2007**

– Genua II with 3 solenidia **17**

– Genua II with 4 solenidia **19**

10 (9) Genua I wth 2 bsl, 6 sts; tibia I with 1 bsl, 6 sts; Pakistan..... ***P. ferventis*** **Muhammad & Chaudhri, 1990**

– Genua I with 2 asl, 3 bsl, 3 sts; tibia I with 1 bsl, 7 sts; Pakistan..... ***P. erinaceus*** **Muhammad & Chaudhri, 1991**

– Genua I with 3 bsl, 6 sts; tibia I with 1 asl, 1 bsl, 6 sts; Pakistan..... ***P. galumma*** **Muhammad & Chaudhri, 1991**

– Genua I with 4 asl, 4 sts; tibia I with 1 asl, 6 sts; Pakistan..... ***P. walii*** **Bashir & Afzal, 2009**

– Genua I with 5 bsl, 4 sts; tibia I with 1 bsl, 6 sts; Pakistan..... **11**

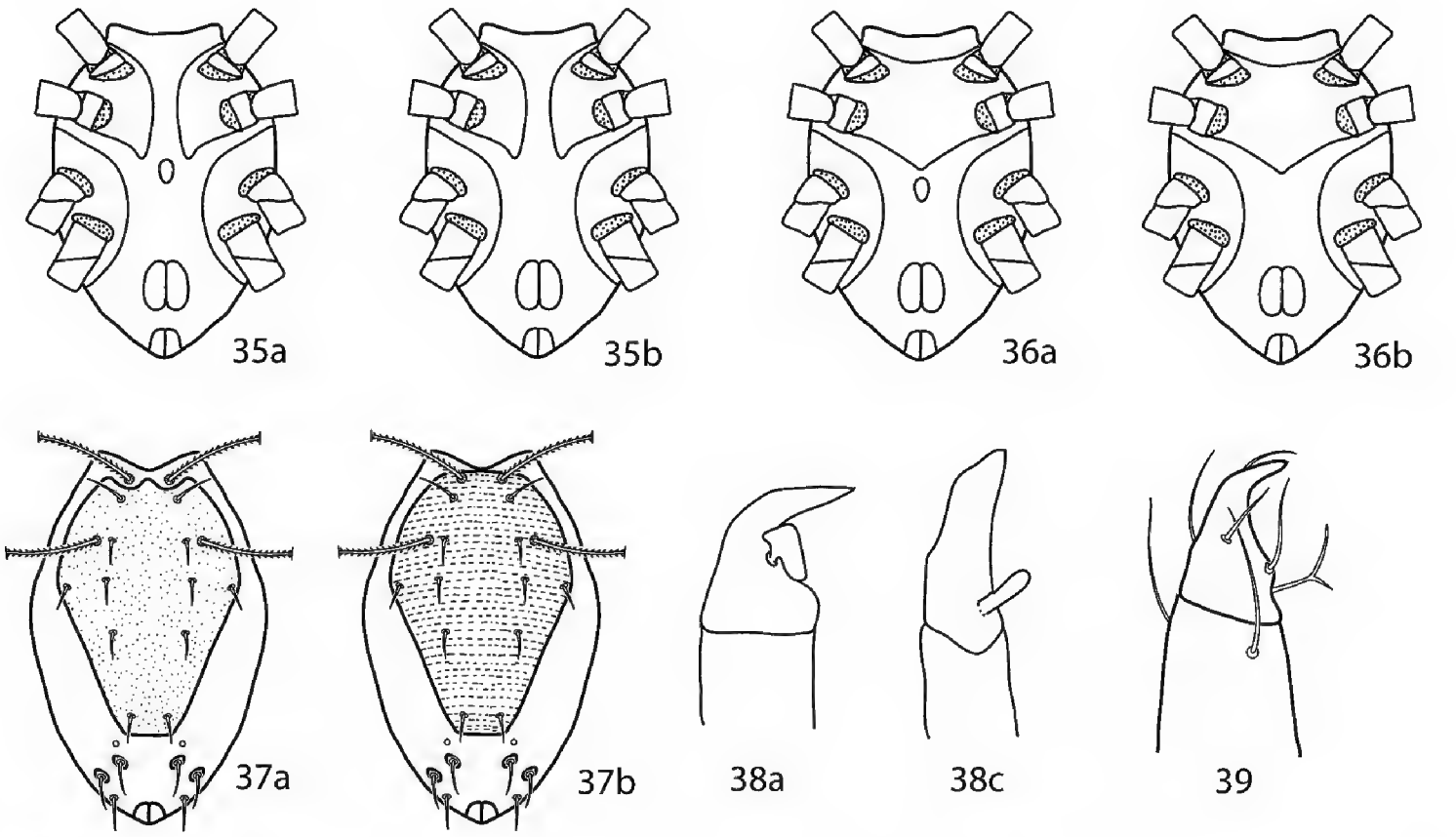
11 (10) Basifemora I–IV setal formula 5-5-4-3; Pakistan..... **P. silicula Muhammad & Chaudhri, 1991**

– Basifemora I–IV setal formula 4-6-3-1; Pakistan..... ***P. stultus*** **Muhammad & Chaudhri, 1991**

12 (9) Basifemora I with solenidion present; telofemora I–IV setal formula 5-5-3-2; Pakistan..... ***P. camar*** **Muhammad & Chaudhri, 1991**

– Basifemora I with solenidion absent; telofemora I–IV setal formula not as above **13**

13 (12) Basifemora II with 5 (rarely 4) sts; Ukraine..... ***P. leonidi*** **Sergeyenko, 2011**
– Basifemora II with 6 sts **14**
14 (13) Genua II with solenidia present **15**
– Genua II with solenidia absent; Pakistan.... ***P. akbari*** **Bashir & Afzal, 2009**
15 (14) Genua II with 1 asl, 5 sts; Ukraine..... ***P. maslovi*** **Sergeyenko, 2011**
– Genua II with 1 bsl, 6 sts **16**
16(15) Genua III–IV setal formula 5 sts–5 sts; Pakistan .....
..... ***P. osculum*** **Muhammad & Chaudhri, 1990**
– Genua III–IV setal formula 5 sts–6 sts; Pakistan .....
..... ***P. haurio*** **Muhammad & Chaudhri, 1991**
– Genua III–IV setal formula 1 bsl, 4 sts–2 bsl, 4 sts; Pakistan .....
..... ***P. verno*** **Muhammad & Chaudhri, 1990**
17 (9) Setae f_1 and h_1 approximately equal in length **18**
– Setae f_1 approximately half the length as h_1; China..... ***P. musci*** **Liang, 1985**
18 (17) Coxa IV with 2 sts; basifemora IV with 2 sts; Brazil.....
..... ***P. myrtaceus*** **Castro & Den Heyer, 2009**
– Coxa IV with 3 sts; basifemora IV with 1 sts; Pakistan .....
..... ***P. anjumi*** **Bashir & Afzal, 2006**
19 (9) Dorsal shield with punctuations (Fig. 37a); Brazil .....
..... ***P. quadrisolenidius*** **Castro & Den Heyer, 2009**
– Dorsal shield with flat broken striae (Fig. 37b); USA.....
..... ***P. whartoni*** **(Baker & Hoffmann, 1948**
20 (7) 4 pairs of setae on integument between coxal and genital plates.....
..... ***P. cinctus*** **(Chaudhri, 1980)**
– 5 pairs of setae on integument between coxal and genital plates..... **21**
– 6 pairs of setae on integument between coxal and genital plates..... **22**
21 (20) Coxae II with 2 sts; telofemora II with 5 sts; Pakistan.....
..... ***P. desitis*** **Muhammad & Chaudhri, 1990**
– Coxae II with 2 sts; telofemora II with 4 sts; Philippines .....
..... ***P. palawanensis*** **Corpuz-Raros, 2007**
22 (20) Sensillum *at* approximately as long as *sce*; setae f_1 approximately equal in length to h_1 ..... ***P. cebuensis*** **Corpuz-Raros, 2007**
– Sensillum *at* longer than *sce*; setae f_1 approximately 1.25 the length of h_1.....
..... ***P. franciscae*** **Den Heyer, 1981**
23 (1) Ventral medial platelet present (Fig. 36a); dorsum punctuate (Fig. 37a); pedipalpal tibiotarsus with truncate, flange-like apophysis (Fig. 38a); USA .....
..... ***P. pectinatus*** **Den Heyer, 1979**
– Ventral medial platelet absent (Fig. 36b); dorsum striated (Fig. 37b); pedipalpal tibiotarsus with elongate apophysis (Fig. 38b) **24**
24 (23) Posterior pedipalpal tibiotarsal seta bifurcate (Fig. 39) .....
..... ***P. neopectinatus*** **(Shiba, 1978)**
– Posterior pedipalpal tibiotarsal seta not bifurcate **25**



Figures 35–39. *Pulaeus* illustrations. **35** Genital setae in a row **36–39** *Pulaeus* key illustrations **36, 37** Venter, setae removed for clairity **36a** Coxae I–II not coalesced medially, median platelet present **36b** Coxae I–II not coalesced medially, median platelet absent **37a** Coxae I–II coalesced medially, median platelet present **37b** Coxae I–II coalesced medially, median platelet absent **38a** Dorsal shield with punctures **38b** Dorsal shield with broken striae **39a–c** Pedipalp tibiotarsus **39a** Tibiotarsus with elongate apophysis **39b** Tibiotarsus with flat apophysis **39c** Tibiotarsus with flange-like apophysis.

25 (24) Pedipalp femurogenua at most 4 times as long as wide; setae f_1 and f_2 approximately equal in length; USA .... ***P. americanus*** **(Baker & Hoffmann, 1948)**

– Pedipalp femurogenua at least 6 times as long as wide; setae f_1 ¼ longer than f_2; Pakistan ..... ***P. krama*** **(Chaudhri, Akbar & Rasool 1979)**

Qunaxella Den Heyer & Castro, 2009

Historical review. Den Heyer and Castro (2009) erected *Qunaxella* for a single species, *Q. triasetosa*.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenu complimented with 5 sts. Tibiotarsi at least twice as long as wide and complemented with 5 sts, 1 asl. **Subcapitulum** with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae).

Idiosoma, *dorsal*. Proterosoma with weakly defined shield present which is complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma lacks a plate. Setae c_1–h_1, c_2, and h_2 present. Setae c_1–f_1 finely setose and c_2, h_1, and h_2 smooth. Setae f_2 absent. Integument not covered in shields or plates striated.

Idiosoma, ventral. **Coxae** weakly sclerotized and ill-defined. Coxae I–II fused. Coxae III–IV fused. Genital plates each bear 4 setae ($g_{1–4}$); 2 pairs of genital papillae

visible underneath the plates. Integument not covered in shields or plates striated. **Legs.** Basifemora I–IV setal formula 3-4-2-0 sts. Telofemora I–IV setal formula 4-4-3-3. Tibiae III with 1 bsl, 5 sts. Tibiae IV with 5 sts (4 short, 1 long).

Scutopalus Den Heyer, 1979

Historical review. Den Heyer (1979c) erected *Scutopalus* for *S. arboreus* and *S. latisetosus*. Shiba (1978) described *Cunaxoides clavatus*. Kuznetzov and Livshitz (1979) described *Cunaxoides trepidus*. Tseng (1980) described *Neocunaxoides osseus* and *N. unguianalis*. Gupta and Ghosh (1980) described *N. pradhani*. Smiley (1992) synonymized *Scutopalus* with *Neocunaxoides* and transferred *C. trepidus* to *Neocunaxoides*. Corpuz-Raros (1996c) described *N. makapalus*, *N. philippinensis*, and *N. rugosus*. Lin and Zhang (2000) recorded *N. clavatus* from tea in China. Sionti and Papadoulis (2003) described *N. abiesae* and *N. smolikensis*. Bashir and Afzal (2004b) described *Neocunaxoides gilbertoi*. Castro and Den Heyer (2009) transferred *P. trepidus* (=*Neounaxoides trepidus*) to *Scutopalus*. Rocha et al. (2013) described *S. tomentosus* and transferred *N. makapalus*, *N. philippinensis*, *N. rugosus*, and *N. unguianalis* to *Scutopalus*.

Diagnosis. *Gnathosoma*. **Pedipalps** 3-segmented. Femurogenu complimented with 5 sts. Tibiotarsi at least twice as long as wide and complemented with 5 sts, 1 asl. Subterminal pointed process on pedipalp tibiotarsal claw absent; small teeth on pedipalp tibiotarsal claw absent. **Subcapitulum** with 6 pairs of setae (hg_{1-4} and 2 pairs of adoral setae). **Chelicera** without seta.

Idiosoma, dorsal. Proterosoma with a well-defined shield present, complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma with a well-defined plate fused to the proterosomal plate. Small platelets may be present laterad and posterior to the dorsal shield. Setae c_1–h_1, c_2, and h_2 present. Setae f_2 absent. Integument not covered in shields or plates striated.

Idiosoma, ventral. **Coxae** well-sclerotized. Coxae I–II fused medially. Coxae III–IV fused. Genital plates each bear 4 setae (g_{1-4}); 2 pairs of genital papillae visible underneath the plates. A small platelet may be present laterad the genital plate. Integument not covered in shields or plates striated. **Legs.** Basifemora I–IV setal formula 3-4-2-0 sts. Telofemora I–IV setal formula 5-5-4-3. Tibiae III with 1 bsl, 5 sts. Tibiae IV with 5 sts (4 short, 1 long).

Key to female *Scutopalus* (modified from Rocha et al. 2013).

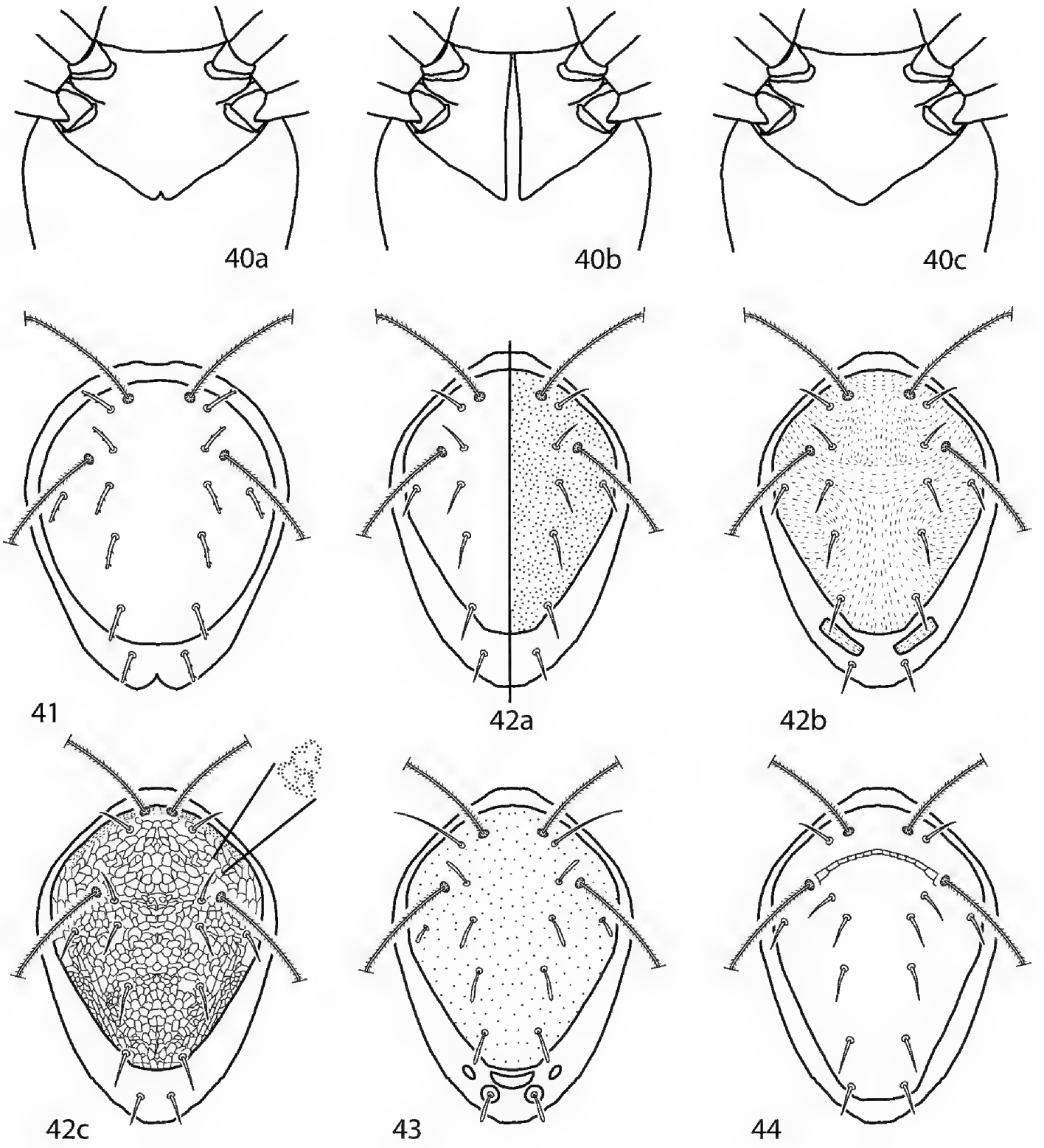
As suggested by Den Heyer (2011b) *Neocunaxoides pradhani* (Gupta and Ghosh 1980) and *N. gilbertoi* (Bashir and Afzal 2004) are transferred to *Scutopalus* as they posses 5 setae on the femurogenu instead of 6 as in *Neocunaxoides* and have well-demarcated plates.

1	Coxae I–II faintly or totally divided (Fig. 40a, b)	**2**
–	Coxae I–II fused medially (Fig. 40c)	7
2 (1)	Coxae I–II faintly divided (Fig. 40a)	**3**

–	Coxae I–II totally divided (Fig. 40b) **4**
3 (2)	Sternal shield bearing 6 pairs of setae; setae c_2 and *mps* simple; coxae II with 2 setae; basifemora I–IV setal formula 3-3-2-0; Greece ..... ***S. abiesae* Sionti & Papadoulis, 2003**
–	Sternal shield bearing 5 pairs of setae; setae c_2 and *mps* setose; coxae II with 1 setae; basifemora I–IV setal formula 2-2-2-1; South Africa ..... ***S. arboreus* Den Heyer, 1979**
4 (2)	At least 2 pairs of thick rod-like setae on the dorsum (Fig. 41); India ..... ***S. pradhani* (Gupta & Ghosh, 1980)**
–	Rod-like setae on dorsal shield absent **5**
5 (4)	Coxae II with 2 sts **6**
–	Coxae II with 3 sts; Pakistan ..... ***S. gilbertoi* (Bashir & Afzal, 2004)**
6 (4)	Setae f_1 and h_1 on small platelets; ratio c_1:c_2 2:1; genua I with 4 asl, 5 sts; genua II with 2 asl, 5 sts; South Africa ..... ***S. latisetosus* Den Heyer, 1979**
–	Setae f_1 and h_1 on integument; ratio c_1:c_2 1:1; genua I with 3 asl, 5 sts; genua II with 1 asl, 5 sts; Greece ..... ***S. smolikensis* Sionti & Papadoulis, 2003**
7 (1)	Dorsal shield smooth and/or punctate (Fig. 42a) **8**
–	Dorsal shield sparse granulate, rugose, or reticulate (Fig. 42b–d) **12**
8 (7)	Coxae II and IV with 2 setae **9**
–	Coxae II and IV with 3 setae **11**
9 (8)	Setae *mps*, c_1, c_2, d_1, e_1, f_1 clavate (Fig. 43); a small subscutum situated posterior to the dorsal shield present; Malaysia ..... ***S. clavatus* (Shiba, 1978)**
–	Setae *mps*, c_1, c_2, d_1, e_1, f_1 setiform; a small subscutum situated posterior to the dorsal shield absent **10**
10 (9)	Setae f_1 on dorsal shield; setae *lps*, *mps*, c_1, c_2, d_1, e_1, f_1 set on tubercles (Fig. 44); area between *pt* more heavily sclerotized, forming ridges; Taiwan ..... ***S. osseus* (Tseng, 1980)**
–	Setae f_1 on integument; setae *lps*, *mps*, c_1, c_2, d_1, e_1, f_1 set normally; area between *pt* normally sclerotized, not forming ridges; Ukraine ..... ***S. trepidus* (Kuznetzov & Livshitz, 1979)**
11 (8)	4 pairs of hysterosomal setae around genital shield; long slender platelet laterad genital shield present; with a narrow transverse sclertie behind main shield; Philippines ..... ***S. philippinensis* (Corpuz-Raros, 1996)**
–	3 pairs of hystersomal setae around genital shield; long slender platelet laterad genital shield absent; dorsal sclerites absent; Philippines ..... ***S. makapalus* (Corpuz-Raros, 1996)**
12 (7)	1 or more dorsal sclerites present (behind or laterad dorsal shield); dorsal shield rugose or reticulate (Fig. 42b, c); basifemora IV with 1 seta; pedipalpal tibiotarsus with 6 setae present and apophysis absent **13**
–	Dorsal sclerites absent; dorsal shield sparsely granulate; basifemora IV with 2 setae; pedipalpal tibiotarsus with 5 setae and a rod-shaped dorsal apophysis present; Taiwan ..... ***S. unguianalis* (Tseng, 1980)**

13 (12) Dorsal shield rugose (Fig. 42b); setae f_1 and h_1 on integument; dorsal setae (except c_2 and h_2) distally rod-like (slightly clavate), with minute barbs; narrow transverse shield behind main dorsal shield present; Philippines..... .....***S. rugosus*** **(Corpuz-Raros, 1996)**

– Dorsal shield reticulate (Fig. 42c); setae f_1 and h_1 on small platelets; dorsal setae (except c_2 and h_2) broad and serrate; sclerites laterad and behind dorsal shield present; Brazil.....***S. tomentosus*** **Rocha, Skvarla & Ferla, 2013**



Figures 40–44. *Scutopalus* key illustrations. **40a** Coxae I–II faintly divided **40b** Coxae I–II totally divided **41** Coxae I–II fused medially **42** Dorsal shield with thick, rod-like setae present **43** Dorsal shield smooth or punctate **44a** Dorsal shield rugose **44b** Dorsal shield reticulate **44c** Dorsal shield sparsely granulate **45a** Setae *mps*, c_1, c_2, d_1, e_1, f_1 clavate **45b** Setae *mps*, c_1, c_2, d_1, e_1, f_1 setiform **46** Setae *lps*, *mps*, c_1, c_2, d_1, e_1, f_1 set on tubercles.

Scirulinae Den Heyer, 1980

Scirula Berlese 1887

Remarks. This is a monobasic subfamily, with the single genus containing two described and one undescribed species. The subfamily and genus are therefore treated together.

Historical review. Berlese (1887) erected *Scirula* for *S. impressa*. Thor and Willmann (1941) and Baker and Hoffmann (1948) redescribed and illustrated *S. impressa.* Den Heyer (1980c) erected Scirulinae for the then monotypic genus. Michocka (1987) reported *S. impressa* from Poland. Smiley (1992) redescribed and illustrated *S. impressa.* Lin (1997) described *S. papillata* from China.

Diagnosis. *Gnathosoma*. **Pedipalps** 4-segmented and do not reach beyond the subcapitulum. A flange-like apophysis present on either the genua or tibiotarsi. Pedipalps end in a stout claw. **Subcapitulum** with 4 pairs of r setae (hg_{1-4}).

Idiosoma, dorsal. Proterosoma covered in a plate which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma may or may not be complemented with a plate. 6 dorsal setae, c_1–h_1, c_2 present. Cupule *im* present.

Idiosoma, ventral. **Coxae** I–IV fused, resulting in a complete shield covering the ventral idiosoma. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Cupule *ih* present. Anal plates bear 2 pairs of setae (ps_1 and ps_2); 1 pair of setae born on integument next to anal plates.

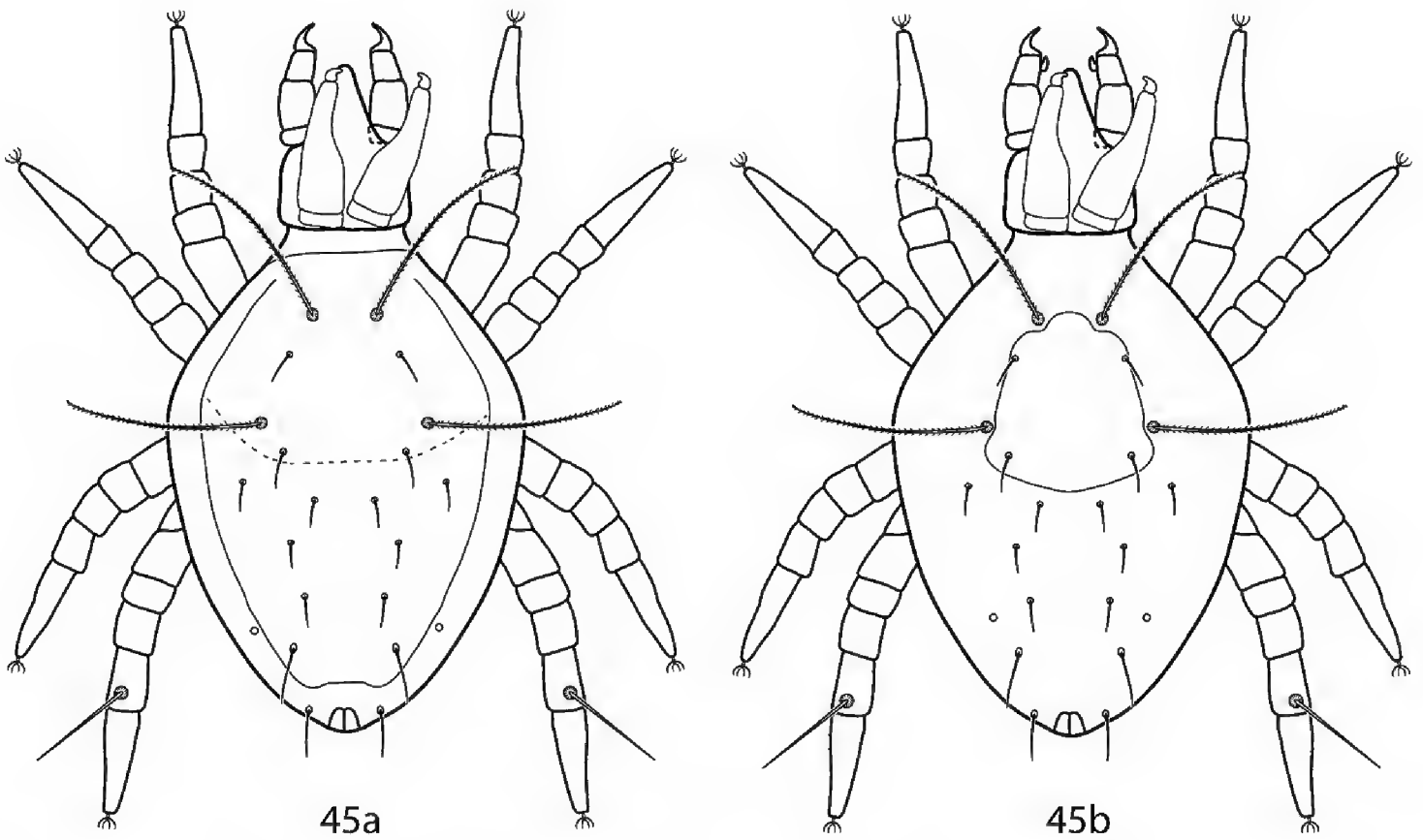
Key to adult female *Scirula*

1 Hysterosomal shield present (Fig. 45a); Japan, USA, Denmark, Italy ..... ***S. impressa* Berlese, 1887**

– Hysterosomal shield absent (Fig. 45b); China, USA ..... ***S. papillata* Lin, 1997**

Cunaxinae Den Heyer, 1978

Historical review. Von Heyden (1826) erected *Cunaxa* for *Scirus setirostris.* Oudemans (1902) used Cunaxinae in the same sense that Trouessart (1892) used Scirinae, that is for those mites in the family Bdellidae (*sensu* Koch) that have pedipalps with a curved terminal segment and movable chela only (= Cunaxidae *sensu* Thor). Oudemans (1906) substituted Cunaxinae for Cunaxidae. Berlese (1916) erected *Dactyloscirus* as a subgenus of *Scirus* to accommodate *Scirus* (*Dactyloscirus*) *eupaloides.* Oudemans (1922) erected *Rosenhofia* to accommodate *R. machairodus*. Vitzthum (1931) raised *Dactyloscirus* to full generic status but later (1940–43) treated it as a subgenus. Thor and Willmann (1941) again elevated *Dactyloscirus* to generic status and designated *Dactyloscirus eupaloides* as the type specimen. Baker and Hoffmann (1948) regarded *Dactyloscirus* as a senior syno-



Figures 45. *Scirula* key illustrations. **45a** *S. impressa* **45b** *S. papillata*.

nym of *Cunaxa*. Smiley (1975) synonymized *Rosenhofia* with *Dactyloscirus*. Den Heyer (1978a) preserved the name Cunaxinae, but limited its concept to those cunaxids possessing 5-segmented pedipalps that extend past the subcapitulum by at least the distal two segments; he also erected *Armascirus*. Den Heyer (1979d) erected *Rubroscirus* for *R. africanus*. Gupta and Ghosh (1980) erected *Indocunaxa*. Smiley (1992) synonymized *Rubroscirus* with *Cunaxa* but failed to give his reasoning for doing so. Den Heyer (2006) erected *Riscus* for a species known only from Thailand. Castro and Den Heyer (2008) erected *Cunaxatricha* and provided a key to the genera of Cunaxinae. Den Heyer and Castro (2008) erected *Allocunaxa* for a Neotropical species, synonymized *Indocunaxa* with *Armascirus*, and provided the most up-to-date key to world genera of Cunaxinae.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and extend beyond the subcapitulum by at least the distal half of the tibiae. Basifemora and telofemora fused but often dark line remains to indicate the division between the segments; telofemora and genua also fused in this manner in *Allocunaxa*. Apophyses may be present on the telofemora and between the genua and tibiotarsi. Tibiotarsi end in a strong claw. **Chelicera** with or without seta. **Subcapitulum** with up to 6 pairs of setae; setae hg_{1-4} always present, 2 pairs of adoral setae present or absent. Setae hg_4 longest. In species with pedipalpal apophyses, the apophyses of the males shorter.

Idiosoma, *dorsal*. Female proterosoma bears a shield complemented with 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Dorsal hysterosoma may bear any combination of a median plate and lateral platelets (i.e., median plate and platelets absent, only median plate present, only lateral platelets present, or both median plate and lateral platelets present). Median plate, if present, may be complemented with 0–6 pairs of dorsal setae; lateral platelets, if present, may bear setae c_2.

Setae not born on plates or platelets may be born on tiny platelets barely larger than the setal socket. Integument that does not bear plates or platelets striated. Males differ in that the dorsal shields often more extensive and may be holodorsal.

Idiosoma, ventral. **Coxae** I–II fused or divided and may coalesce medially to form a sternal shield; coxae III–IV fused or divided and may extend caudally past the genital plates. Coxae each complemented 0–3 setae. Genital plates each bear 4 setae (g_{1-4}); 2 pairs of genital papillae visible underneath the plates. Anal plates complemented with at least one pair of setae, ps_1. Setae ps_2 present or absent, either on the anal plates or on the integument adjacent to the anal plates. Setae h_2 present ventrally on the integument adjacent to the anal plates. Cupule *ih* present laterad of h_2. Integument that does not bear plates striated. **Legs.** Tarsi constricted apically so as to end in lobes. A trichobothrium on tibia IV present or absent.

Key to adult female Cunaxinae (modified from Den Heyer and Castro 2008a)

1 Anal seta ps_2 absent; pedipalp telofemora with dorsal simple seta (Figs 46a–e); tarsal lobes small to medium size (Fig. 47a); dorsal plates reticulated or not (Figs 48a–c) Cunaxini **2**

– Anal seta ps_2 present; pedipalp telofemora with dorsal spine-like seta (Figs 46f,g); tarsal lobes medium to large size (Fig. 47b); dorsal plates always reticulated (Fig. 48c) Armascirini **6**

2 (1) Dorsal plates never reticulated (Figs 48a, b); integumental striae smooth or lobed; coxae II–IV setal formula usually 1-3-2 (rarely 2-3-1) ..... ***Cunaxa*** **Von Heyden, 1826**

– Dorsal plates usually reticulated (Fig. 48c); integumental striae usually papillated; coxae II–IV setal formula usually 1-3-1 ..... **3**

3 (2) Pedipalpal telofemora with one or more apophyses (Fig. 46a); sensillae *at* and *pt* not densely pilose ..... ***Rubroscirus*** **Den Heyer, 1979**

– Pedipalpal telofemora without apophyses (Figs 46b–e); sensillae *at* and *pt* densely pilose **4**

4 (3) Tibiae IV trichobothrium present **5**

– Tibiae IV trichobothrium absent .. *Cunaxatricha* Castro & Den Heyer, 2008

5 Articulation joint between pedipalpal telofemora and genua functional (Fig. 46b) ..... ***Riscus*** **Den Heyer, 2006**

– Articulation joint between pedipalpal telofemora and genua fused/non-functional (Fig. 46c) ..... ***Allocunaxa*** **Den Heyer & Castro, 2008**

6 (1) Pedipalpal basifemora with simple seta (Fig. 46f); coxae II–IV setal formula usually 1-3-3 (male) or 2-3-3 (female); famulus normal; pedipalpal apophyses (when present) usually long in females and short in males, and with pointed apices (Fig. 46f) ..... ***Armascirus*** **Den Heyer, 1978**

– Pedipalpal basifemora with spine-like seta (Fig. 46g); coxae II–IV setal formula usually 3-3-3; famulus large, broad based with tri-pronged tip; pedipalpal apophyses (when present) usually equal length in females and males, and with bulbous apices (Fig. 46g) ..... ***Dactyloscirus*** **Berlese, 1916**

Allocunaxa Den Heyer & Castro, 2008

Historical review. Den Heyer and Castro (2008a) erected *Allocunaxa* for *A. heveae*.

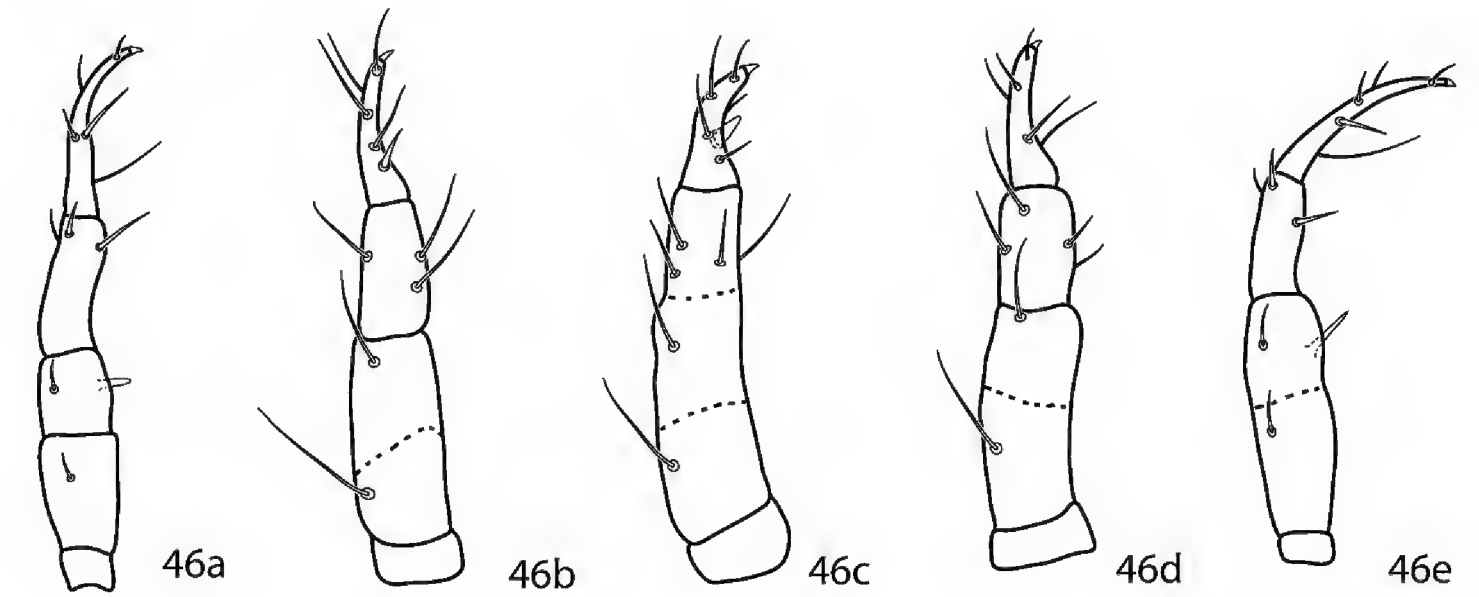
Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented, end in a strong claw, and extend beyond the subcapitulum by at least the last segment. Pedipalpal apophyses absent. Basifemora complemented with a long simple seta and telofemora with a short simple seta; these two segments fused, although a line remains visible and they can thus be differentiated. Telofemora and genu nearly fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae (hg_{1-4} and 2 pairs of adoral setae) and covered by integumental papillae.

Idiosoma, dorsal. Proterosoma with an ill-defined, weakly sclerotized shield that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). 7 pairs of setae, c_{1-2}, d_1–h_1, present. Cupule *im* present, usually posteriolaterad of e_1. Integument striated.

Idiosoma, ventral. **Coxae** I and II fused. Coxae III and IV fused. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Integument between plates striated and bears 4 pairs of additional setae. **Legs** shorter than the body. Leg 4 longest. Famulus on tarsi I normally shaped. Tarsi constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a 4-rayed empodium present.

Armascirus Den Heyer, 1978

Historical review. The first *Armascirus* was described by Kramer (1881) as *Scirus taurus*. Berlese (1888) described *S. taurus* var. *bison*. Banks (1894) described *S. quadripilis*. Thor (1902) transferred *S. taurus* to *Cunaxa*. Banks (1914) described *C. armata*. Miller (1925) reported *S. quadripilis* from Ohio. Womersley (1933) reported *C. taurus* from Australia. Thor and Willmann (1941) transferred *S. taurus* var. *bison* to *Cunaxa* and raised it to full species status, viz. *C. bison* and transferred *S. quadripilis* to *Cunaxa*; they also redescribed and figured *C. armata*, *C. bison*, *C. quadripilis*, and C. *taurus*. Baker and Hoffmann (1948) synonymized *S. quadripilis* and *C. armata* with *C. taurus*; they followed Thor and Willmann (1941) in placing *C. taurus* var. *bison* in *Cunaxa* but declined to recognize it as a species and instead kept it as a variety or subspecies of *C. taurus*. Zaher et al. (1975b) collected *C. taurus* in Egypt. Chaudhri (1977) described *Dactyloscirus ebrius* and *D. fuscus* from Pakistan. Den Heyer (1978a) split *Armascirus* from *Dactyloscirus* and *Cunaxa* and raised the subfamily Cunaxinae to accommodate them, thus refining the definitions of all three genera; he transferred *C. taurus* and *C. bison* to the new genus *Armascirus*; and described *A. huyssteeni*, *A. lebowensis*, *A. limpopoensis*, and *A. albiziae*. Kuznetzov and Livshitz (1979) redescribed and figured *C. taurus* and *C. bison* from Russia, either disagreeing with or being unaware of Den Heyer's 1978 publication. Tseng (1980) reported *A. taurus* from Taiwan. Chaudhri (1980) described *D. fixus* from Pakistan. Den Heyer (1980c) erected the tribe Armascirini and



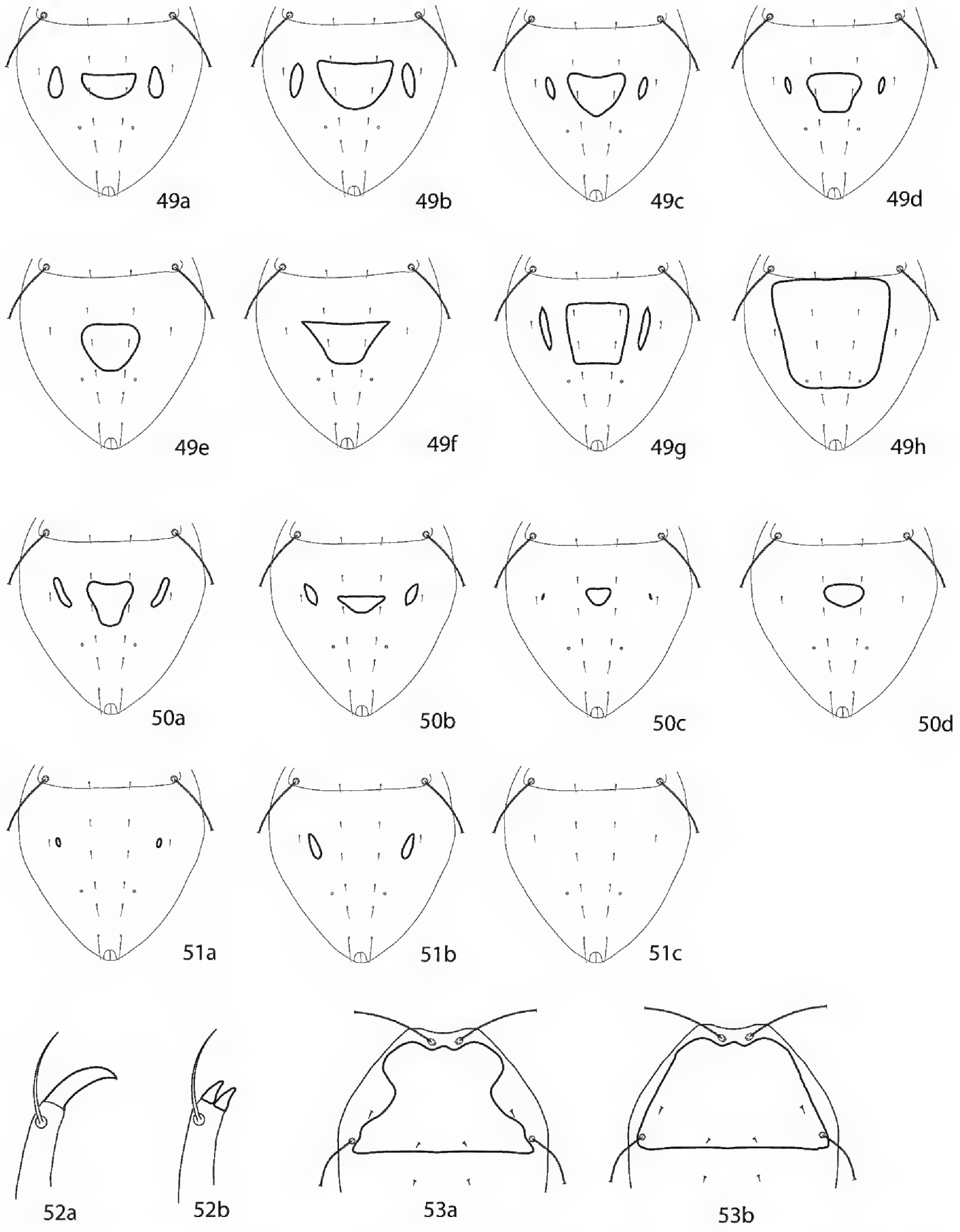
Figures 46–48. Cunaxinae key illustrations. **46** Pedipalps, dorsal **46a** *Rubroscirus* **46b** *Riscus* **46c** *Allocunaxa* **46d** *Cunaxatricha* **46e** *Cunaxa* **46f** *Armascirus* **46g** *Dactyloscirus*. 47a, b. Distal end of tarsus **47a** *Armascirini*, showing large tarsal lobes **47b** *Cunaxini*, showing small to medium tarsal lobes **48a–c** Idiosoma, dorsal. Setae and cupules have been removed for clairity. Shape of proterosomal plate and presence or absence, shape, and extent of hysterosomal plate(s) will differ between species **48a** Plates smooth **48b** Plates with dot-like pattern **48c** Plates with reticulated pattern.

made *Dactyloscirus* and *Armascirus* the sole representatives. Gupta and Ghosh (1980) erected *Indocunaxa*, a monotypic genus with *I. smileyi* as the type species. Liang (1983) reported *A. taurus* from China. Shiba (1986) described *A. hastus* and *A. multioculus*. Michocka (1987) described *D. rafalskii* from Poland. *A. mactator* and *A. pluri* were described by Muhammad and Chaudhri (1991b). Smiley (1992) described *A. gimplei*, *A. anastosi*, *A. harrisoni*, *A. heryfordi*, *A. virginiensis*, *D. bakeri*, and *D. campbelli*; he also transferred *A. bison* to *Dactyloscirus* (which was later returned to *Armascirus* by Den Heyer and Castro 2008a). Corpuz-Raros (1995) described *A. garciai* and *A. makilingensis* from the Philippines. Hu (1997) reported *A. bison* and *A. taurus* from China. Bashir and Afzal (2005) described *A. satianaensis* and *A. asghari*. Corpuz-Raros and Gruèzo (2007) described *A. javanus*. Corpuz-Raros (2008) described *D. bifidus*. Bashir, Afzal, and Khan (2008) described four species from Pakistan: *A. akhtari*, *A. jasmina*, *A. sabrii*, and *A. gojraensis*. Den Heyer and Castro (2008a) synonymized *Indocunaxa* with *Armascirus* and transferred *D. bison*, *D. campbelli*, *D. ebrius*, *D. fixus*, *D. fuscus*, and *D. rafalskii* to *Armascirus*. . Corpuz-Raros (2008) described *A. apoensis*. Kalúz (2009) described *A. cyaneus* and *A. cerris* from Central Europe Skvarla and Dowling (2012) described *A. ozarkensis*, *A. pennsylvanicus*, and *A. primigenius*. Den Heyer and Castro (2012) described *A. brasiliensis* and *A. bahiaensis*. Kalúz and Vrabec (2013) described *A. fendai* and *A. masani*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented, end in a strong claw, and extend beyond the subcapitulum by at least the last segment. Apophysis between the genua and tibiotarsi, which tapers to a point, usually present; this apophysis shorter in males than in females. Basifemora complemented with a simple seta; telofemora with a spine-like seta. These two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae (hg_{1-4} and 2 pairs of adoral setae). It can be covered by integumental papillae which are either randomly distributed or form a polygonal, reticulated pattern.

Idiosoma, dorsal. Female dorsal idiosoma with at least one sclerotized plate that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). 0–4 other major plates and platelets may also be present. All plates, if present, covered by integumental papillae that form a reticulated pattern. Integument between the plates is striated. 7 pairs of setae, c_{1-2}, d_1–h_1, present. Each seta, when not on a major plate or platelet, surrounded by a minute platelet that is only slightly larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of e_1. Dorsal idiosoma of males is similar except a single large plate complemented with c_{1-2}, d_1–e_1 present.

Idiosoma, ventral. **Coxae** reticulated in the same manner as the dorsal plates. Coxae I–II often fused; Coxae III–IV often fused. Setal formula of coxae I–IV in males 3-1-3-3 (including the paracoxal seta), in females 3-2-3-3 (including the paracoxal seta). Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (ps_1). 2 pairs of setae (ps_2 and h_2) associated with but do not occur on the anal plates. Cupule *ih* present in close proximity to h_2. Integument between plates striated and bears 5–7 pairs of additional setae. The ventral idiosoma



Figures 49–53. *Armascirus* key illustrations. **49–51** Dorsal idiosoma **49a–e** Hysterosomal shield complemented with setae **50a–d** Hysterosomal shield small, not complemented with setae **51a–c** Hysterosomal shield absent **52a, b** Pedipalp tibiotarsal claw **52a** Single claw **52b** Bifid claw **53a** Hysterosomal plate concave on lateral edges **53b** Hysterosomal plate not concave on lateral edges.

of males similar except the coxae are much more extensive. A sclerotized aedeagus is often visible in association with the genital plates. **Legs** comparatively long, at least ¾ the length, and often longer than the body. Famulus on tarsi I normally shaped. Tarsi are constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female *Armascirus* (modified from Kalúz and Vrabec 2013)

Dactyloscirus bifidus Corpuz-Raros, 2008 is transferred to *Armascirus* as it posessess a spine-like seta on the pedipalpal basifemora.

Armascirus gojraensis and *A. sabrii* appear to be nymphs based on the leg setal counts given in the original descriptions. Having not seen the type material, however, they are retained within the key. Caution should be exercised if these species are reached.

1 Hysterosomal median shield present (Figs 49a–h, 50a–d) **2**
– Hysterosomal median shield absent (Figs 51a–c) **30**
2 (1) Median shield complemented with setae, small or large (Figs 49a–h) **3**
– Median shield not complemented with setae, small (Figs 50a–d) **22**
3 (2) One pair of setae (d_1) on hysterosomal median shield (Figs 49a–f) **4**
– Two or more pairs of setae on hysterosomal median shield (Figs 49g–h) ... **18**
4 (3) Lateral hysterosomal platelets present (Figs 49a–d) **5**
– Lateral hysterosomal platelets absent (Figs 49e,f) **15**
5 (4) Setae c_1 very short, the distance between the bases of c_1–c_1 20 times the length of c_1; venter caudally from coxae II with 5 pairs of simple setae (excluding genital, coxal, and anal setae); Poland ..... ***A. rafalskii* (Michocka, 1987)**
– Setae c_1 longer, the distance between the bases of c_1–c_1 less than 10 times the length of c_1; venter caudally from coxae II with 6 or more pairs of simple setae (excluding genital, coxal, and anal setae) **6**
6 (5) .The distance between caudal parts of hysterosomal lateral platelets wider than the distance between their frontal parts (Figs 49a,b) **7**
– The distance between caudal parts of hysterosomal lateral platelets shorter than the distance between their frontal parts (Figs 49c,d) **9**
7 (6) ..... Lateral hysterosomal platelets equal to or longer than hysterosomal median shield (Fig 49a); venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae); Pakistan..... ..... ***A. jasmina* Bashir, Afzal & Khan, 2008**
– Lateral hysterosomal platelets shorter than hysterosomal median shield (Fig 49b); venter caudally from coxae II with 7 pairs of simple setae (excluding genital, coxal, and anal setae) **8**
8 (7) Pedipalpal genua with 3 spls, 1 sts; important leg I–IV sts chaetotaxy: coxae 3-1-3-2, basifemora 4-5-3-1, genua 8-8-6-5, tibiae 5-6-6-6, tarsi 15-12-8-9; Pakistan ..... ***A. akhtari* Bashir, Afzal & Khan, 2008**
– Pedipalpal genua with 3 spls; important leg I–IV sts chaetotaxy: coxae 3-2-3-3, basifemora 4-4-3-3, genua 8-4-6-7, tibiae 6-5-6-5, tarsi 11-10-9-7; Pakistan .... ***A. satianaensis* Bashir & Afzal, 2005**
9 (6) Venter caudally from coxae II with 4 pairs of simple setae (excluding genital, coxal, and anal setae); Brazil..... ..... ***A. bahiaensis* Den Heyer & Castro, 2012**
– Venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae) **10**

–	Venter caudally from coxae II with 7 pairs of simple setae (excluding genital, coxal, and anal setae) **14**
–	Venter caudally from coxae II with 8 pairs of simple setae (excluding genital, coxal, and anal setae); South Africa ..... ***A. albiziae*** **Den Heyer, 1978**
10 (9)	Tarsus I with more than 27 setae; tarsus II with at least 24 setae **11**
–	Tarsus I with less than 25 setae; tarsus II with less than 23 setae **12**
11 (10)	Leg genua I with 4 bsl, 4 sts; genital valve with random dot-like lobes; tarsal sts chaetotaxy I–IV 29-25-23-22; Pakistan ..... ***A. pluri*** **Muhammad & Chaudhri, 1991**
–	Leg genua I with 2 asl, 4 bsl, 3 sts; genital valve longitudinal rows of dot-like lobes; tarsal sts chaetotaxy I–IV 29-24-22-21; Pakistan ..... ***A. mactator*** **Muhammad & Chaudhri, 1991**
12 (10)	Pedipalpal telofemora with 1 apophysis, 2 spls; pedipalpal genua with 1 ap, 2 spls, 2 sts; South Africa ..... ***A. huyssteeni*** **Den Heyer, 1978**
–	Pedipalpal telofemora with 1 apophysis, 1 spls; pedipalpal genua with 1 ap, 3 spls, 1 sts **13**
13(12)	Genua II with 1 asl, 5 sts; genua IV with 2 asl, 5 sts; cosmopolitan ..... ***A. Taurus*** **(Kramer, 1881)**
–	Genua II with 1 asl, 6 sts; genua IV with 1 asl, 4 or 5 sts; USA ..... ***A. primigenius*** **Skvarla & Dowling, 2012**
14 (9)	Median shield pointed caudally (Fig. 49c); Pakistan ..... ***A. asghari*** **Bashir & Afzal, 2005**
–	Median shield truncated caudally (Fig. 49d); Brazil ..... ***A. brasiliensis*** **Den Heyer & Castro, 2012**
15 (4)	Hysterosomal median shield with a straight or concave frontal margin and with very acute anterior lateral corners (angle less than 45°) (Fig. 49e) **16**
–	Hysterosomal median shield with convex frontal margin and with rounded anterior lateral corners (Fig. 49f) **17**
16 (15)	Pedipalpal genua with 1 ap, 2 spls, 1 sts; legs I–IV sts formulae (excluding solenidia): basifemora 1-2-1-0; telofemora 4-4-4-4; genua 6-7-5-6; h_1 4 times the length of c_1; hysterosomal shield width: length = 2.2:1; Pakistan ..... ***A. sabrii*** **Bashir, Afzal & Khan, 2008**
–	Pedipalpal genua with 1 ap, 3 spls, 1 sts; legs I–IV sts formulae (excluding solenidia): basifemora 2-2-1-1; telofemora 4-4-4-3; genua 8-6-6-6; h_1 3 times the length of c_1; hysterosomal shield width: length 1.5:1; Pakistan ..... ***A. gojraensis*** **Bashir, Afzal & Khan, 2008**
17 (15)	Apophysis adjoining genu and tibiotarsus shorter than pedipalpal tibiotarsus; pedipalpal telofemoral apophyses three times longer than spine-like seta; distance between the bases of *sci–sci* 9 times the length of *sci*; Brazil, Mexico .... ***A. bison*** **(Berlese, 1988)**
–	Apophysis adjoining genu and tibiotarsus longer than pedipalpal tibiotarsus; pedipalpal telofemoral apophyses three times longer than spine-like seta; distance between the bases of *sci–sci* 5 times the length of *sci*; Pakistan ..... ***A. fixus*** **(Chaudhri, 1980)**

18 (3) Hysterosomal median shield with 2 pairs of setae (c_1, d_1) (Fig. 49g).....**19**
– Hysterosomal median shield with more than 3 pairs of setae (Fig. 49h)....**20**
19 (18) Pedipalpal telofemora with 2 ap, 1 spls; pedipalpal genua with 2 spls, 2 sts; venter caudally from coxae II with 6 pairs of simple setae (excluding genital, coxal, and anal setae); tarsi I–IV with 21-20-15-13 sts (excluding solenidia); the distance between bases of c_1–c_1 4 times the distance of h_1–h_1; distance between c_1–c_1 5 times the length of c_1.....***A. anastosi* Smiley, 1992**
– Pedipalpal telofemora with 1 ap, 1 spls; pedipalpal genua with 3 spls, 1 sts; venter caudally from coxae II with 5 pairs of simple setae (excluding genital, coxal, and anal setae); tarsi I–IV with 19-13-13-13 sts (excluding solenidia); the distance between c_1–c_1 2 times the distance between h_1–h_1; the distance between c_1–c_1 4 times the length of c_1.....***A. heryfordi* Smiley, 1992**
20 (18) Apophysis adjacent to pedipalpal genua and tibiotarsi present .....
.....***A. multioculus* Shiba, 1986**
– Apophysis adjacent to pedipalpal genua and tibiotarsi absent.....**21**
21 (20) 5 pairs of genital setae; pedipalp claw bifid (Fig. 52a); hysterosomal setae not serrate; Philippines.....***A. apoensis* Corpuz-Raros, 2008**
– 4 pairs of genital setae; pedipalp claw entire, not bifid (Fig. 52b); hysterosomal setae serrate; Pakistan.....***A. fuscus* (Chaudhri, 1977)**
22 (2) Lateral hysterosomal platelets present (Figs 50a–c).....**23**
– Lateral hysterosomal platelets absent (Fig. 50d) **27**
23 (22) Hysterosomal median shield width: length 1:1; venter caudally from coxae II with 6 or 7 pairs of sts (excluding genital and anal setae) **24**
– Hysterosomal median shield width: length 2:1; venter caudally from coxae II with 5 or 6 pairs of sts (excluding genital and anal setae) **25**
24 (23) Hysterosomal platelets large, as long as median shield (Fig. 50a); venter caudally from coxae II with 7 sts; pedipalp telofemur with 1 apophysis.....
.....***A. cerris* Kalúz, 2009**
– Hysterosomal platelets about 1/3 the length of median shield; venter caudally from coxae II with 6 sts; pedipalp telofemur with 2 apophysis .....
.....***A. fendai* Kalúz & Vrabec, 2013**
25 (23) Hysterosomal platelets as long as median shield (Fig. 50b) **26**
– Hysterosomal platelets ½ as long as median shield (Fig. 50c); Mexico, USA ..
.....***A. gimplei***
26 (25) Hysterosomal plate concave on lateral edges (Fig. 53a); USA.....
.....***A. ozarkensis* Skvarla & Dowling, 2012**
– Hysterosomal plate not concave on lateral edges (Fig. 53b); Japan.....
.....***A. hastus* Shiba, 1986**
27 (22) Apophysis on pedipalp telofemur extends to distal margin of segment; 2 pairs of ventral pregenital setae thickened and spiculate; f_1 1/3 length of h_1; Philippines.....***A. makilingensis* Corpuz-Raros, 1995**
– Apophysis on pedipalp telofemur extends well beyond distal margin of segment; ventral pregenital setae not thickened and spiculate; f_1 subequal to h_1..... 28

28 (27) Pedipalpal telofemora with 2 ap, 1 spls; the distance between the bases of c_1–c_1 two times the distance of d_1–d_1; South Africa..... ***A. limpopoensis*** **Den Heyer, 1978**

– Pedipalp telofemora with 1 ap, 1 spls; the distances between the bases of c_1–c_1 = d_1–d_1 ..... **29**

29 (28) Pedipalp tibiotarsus with 1 spls, 4 sts; USA..... ***A. harrisoni*** **Smiley, 1992**

– Pedipalp tibiotarsus with 1 spls, 3 sts; Canada ..... ***A. bakeri*** **(Smiley, 1992)**

30 (1) Pedipalpal telofemoral apophyses long, reaching apical apophysis on pedipalpal genu; lateral platelets present..... **31**

– Pedipalpal telofemoral apophyses short, not reaching apical apophysis on pedipalpal genu; lateral platelets present or absent..... **32**

31 (30) Pedipalpal basifemora with 1 subrectangular apophysis; pedipalp tibiotarsal spls 3 times the length of terminal claw; hysterosomal platelets small, equal in length to c_2 (Fig. 51a); coxal chaetotaxy I–IV 3-2-3-3; South Africa ..... ***A. lebowensis*** **Den Heyer, 1978**

– Pedipalpal basifemora without subrectangular apophysis; pedipalp tibiotarsal spls equal in length to terminal claw; hysterosomal platelets long, 2–3 times the length of c_2 (Fig. 51b); coxal chaetotaxy I–V 3-1-3-1; USA..... ***A. campbelli*** **(Smiley, 1992)**

32 (30) Coxal setal count I–IV 3-2-3-3 ..... **33**

– Coxal setal count I–IV 3-2-3-2 ..... **35**

– Coxal setal count I–IV 3-3-3-3 ..... ***A. bifidus*** **(Corpuz-Raros, 2008)**

33 (32) Pedipalpal telofemora with 1 apophysis, 2 spls, 1 sts; the distance between d_1–d_1 9 times the length of d_1; pedipalpal genua with 2 spls, 1 sts; Slovakia .. ***A. cyaneus*** **Kalúz, 2009**

– Pedipalpal telofemora with 1 apophysis, 2 spls; the distance between d_1–d_1 4 times the length of d_1; pedipalpal genua chaetotaxy not as above **34**

34 (33) Hysterosomal platelets present (Fig 51b); pedipalpal genua with 2 spls, 2 sts; basifemora with 5-5-4-2 sts; USA ..... ***A. virginiensis*** **Smiley, 1992**

– Hysterosomal platelets absent (Fig. 51c); pedipalpal genua with 1 spls, 1 sts; basifemora with 6-6-4-2 sts; Philippines ..... ***A. javanus*** **Corpuz-Raros & Gruèzo, 2007**

35 (32) Pedipalpal telofemoral apophyses as long as width of telofemora; pedipalpal genu with 1 apophysis, 2 spls, 2 sts; USA..... ***A. pennsylvanicus*** **Skvarla & Dowling, 2012**

– Pedipalpal telofemoral apophyses only 1/3 width of telofemora; pedipalpal genu with 1 apophysis, 3 spls, 1 sts; Philippines..... ***A. garciai*** **Corpuz-Raros, 1995**

Key to adult male *Armascirus* (modified from Kalúz and Vrabec 2013)

1 Venter with 5 or fewer pairs of setae, excluding genital, anal, and adanal setae; setal formula of coxae I–IV not as below; setal formula of basifemora I–IV not as below..... **2**

– Venter with 6 pairs of setae, excluding genital, anal, and adanal setae; setal formula of coxae I–IV 3-2-3-3; setal formula of basifemora I–IV 5-5-4-2; cosmopolitan ..... ***A. taurus* (Kramer, 1881)**

2 (1) Setal formula of basifemora I–IV 5-5-4-1; Pakistan ..... ***A. ebrius* (Chaudhri, 1977)**

– Setal formula of basifemora I–IV not as above **3**

3 (2) Coxae I–IV setal formula 3-1-3-3; papillae on circular region anterior to setae *pt* present; South Africa ..... ***A. huyssteeni* Den Heyer, 1978**

– Coxae I–IV setal formula 3-2-3-3; papillae on circular region anterior to setae *pt* present or absent **4**

4 (3) Setal formula of basifemora I–IV 5-4-3-0; papillae on circular region anterior to setae *pt* present; South Africa ..... ***A. limpopoensis* Den Heyer, 1978**

– Setal formula of basifemora I–IV not as above; papillae on circular region anterior to setae *pt* absent; South africa **5**

5 (4) Genua I with 3 asl, 5 sts; South Africa ..... ***A. lebowensis* Den Heyer, 1978**

– Genua I with 2 asl, 1 mst, 5 sts; Ukraine ..... ***A. masani* Kalúz & Vrabec, 2013**

***Cunaxa* Von Heyden, 1826**

Historical review. Hermann (1804) erected *Scirus* for *S. setirostris* and placed it with two mites that are now considered to belong to the family Bdellidae. Von Heyden (1826) erected *Cunaxa* for *Scirus setirostris.* Dugés (1834a) described *S. elaphus*. Dugés (1834b) described *S. tenuirostris*. Koch (1836) described *S. stabulicola* and *S. sagax* and later (1838) *S. paludicola*. Gervais (1841) described *S. obisium.* Berlese (1887) described *S. capreolus*. Berlese (1888) synonymized *S. elaphus*, *S. stabulicola*, *S. sagax*, and *S. paludicola* with *S. setirostris.* Thor (1902) erected Cunaxidae and split *Cunaxa* from Bdellidae. Ewing (1913) described *S. laricis*. *S. setirostris* var. *gazella* was described by Berlese (1916). Thor and Willmann (1941) redescribed and figured *S. laricis* after transferring it to *Cunaxa*; they also transferred *S. setirostris* var. *gazella* to *Cunaxa*, though kept it as a subspecies of *C. setirostris* and synonymized *S. tenuirostris* and *S. obisium* with *C. setirostris*. Baker and Hoffmann (1948) redescribed and figured *C. setirostris* var. *gazella* and *C. capreolus* and described *C. womersleyi* and *C. veracruzana*. Zaher et al. (1975b) reported *C. setirostris* and *C. capreolus* from Egypt. Den Heyer (1978a) erected Cunaxinae and assigned *Cunaxa* to the subfamily. Den Heyer (1979e) elevated *C. setirostris* var. *gazella* to full species status, viz. *C. gazella*; described *C. carina*, *C. terrula*, *C. lamberti*, *C. meiringi*, and *C. grobleri* and redescribed and figured *C. capreola* and *C. gazella*. He then (Den Heyer 1979f) described five more species from South Africa: *C. hermanni*, *C. sordwanaensis*, *C. potchensis*, *C. brevicrura*, and *C. magoebaensis*. Kuznetzov and Livshitz (1979) redescribed and figured *C. capreolus* and *C. setirostris* from Russia. Chaudhri (1980) described *C. doxa*. Tseng (1980) reported *C. womersleyi* and *C. setirostris* from Taiwan. Gupta and Ghosh (1980) described *C. myabunderensis*. Gupta and Paul (1985) described *C. prinia*. Bu and Li (1987c) reported *C. capreola* from China.

Michocka (1987) reported *C. setirostris* from Poland. Muhammad et al. described *Rubroscirus valentis* from Pakistan. Smiley (1992) described *C. mageei*, *C. thailandicus*, *C. evansi*, and *C. neogazella*; he also synonymized *Rubroscirus* with *Cunaxa*, though failed to include his evidence for doing so. Gupta (1992) described *C. anacardae* and *C. magniferae*. Muhammad and Chaudhri (1993) described *Rubroscirus rasile* and *R. otiosus* from Pakistan. Corpuz-Raros and Garcia (1995) described five species from the Philippines: *C. luzonica*, *C. romblonensis*, *C. pantabanganensis*, *C. cogonae*, and *C. mercedesae*. Hu (1997) reported 28 species of Cunaxidae from China. Khaustov and Kuznetzov (1998) described *C. heterostriata*, *C. anomala*, *C. sudakensis* and *C. bochkovi*. Chinniah and Mohanasundaram (2001) described *C. eupatoriae*. Sergeyenko (2003) described *C. dentata*. Sionti and Papadoulis (2003) described *C. thessalica* from Greece. Bei et al. recorded *C. mageei* from China. Bashir, Afzal, and Ali (2005) described *C. reticulatus* and moved *Rubroscirus valentis*, *R. rasile*, and *R. otiosus* to *Cunaxa*. Bashir and Afzal (2006) described *C. jatoiensis*. Sergeyenko (2009) described *C. gordeevae*, *C. guanotoleranta*, *C. maculata*, *C. papuliphora*, *C. violaphila* and *C. yaylensis*. Den Heyer and Sergeyenko (2009) redescribed *C. setirostris* and designated a neotype for the species. Bashir and Afzal (2009) described *C. bashiri*, *C. clusus*, *C. dotos*, *C. lodhranensis*, *C. mahmoodi*, *C. nankanaensis*, *C. okaraensis*, *C. pakpatanensis*. Bashir et al. (2010) described *C. rafiqi* and *C. leuros*. Bashir et al. (2011) "described" *C. nankanaensis* as a new species using the same illustrations Bashir and Afzal (2009) used to describe the species originally. Den Heyer et al. (2011a) described the male of *C. capreolus*.

Diagnosis. *Gnathosoma*. **Pedipalps**–5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. An apophysis on the telofemora present or absent. Dorsolateral setae on the basi- and telofemora simple. Stout spine-like setae on the genua and tibiotarsi present or absent. Tibiotarsi end in a strong claw. **Subcapitulum** with 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae ($hg_{1–4}$). Subcapitulum smooth or patterned with random dots, but never reticulated.

Idiosoma, dorsal. Proterosoma bears a shield that is complemented with 2 pairs of setae (*at* and *pt*) and 2 pairs of setose sensillae (*lps* and *mps*). Dorsal hysterosoma may bear a shield; if a shield is present, it may bear up to 4 pairs of setae. Dorsal shields may be smooth or patterned with random dots, but never reticulated. Lateral platelets (as in *Armascirus* and *Dactyloscirus*) absent. Setae c_1–h_1, and c_2 present. Setae not born on the median plate may be born on small platelets that are barely larger than the setal socket. Cupule *im* present laterad and caudally of e_1. Integument not bearing the proterosomal shield and median plate (if present) striated. These striations smooth or lobed but never papillated.

Idiosoma, ventral. **Coxae** I–II may be fused and coxae III–IV may be fused. Coxae II–IV setal formula 1-3-2. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (ps_1). 1 pair of setae (h_2) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to h_2. Integument between plates striated and bears up to 7 pairs of additional setae. **Legs.** Tarsi long and slender. Tarsi constricted distally but the tarsal lobes are small and not conspicuous as in *Armascirus* and *Dactyloscirus*. A trichobothrium on tibia IV present. Ambulacral claws on either side of a 4-rayed empodium present.

Key to adult female *Cunaxa*

Cunaxa bochkovi is not included in the key because the original description is in Cyrillic and the illustration does not contain enough detail or diagnostic characteristics. Den Heyer (pers. comm., Jan. 13, 2014) indicated that *Cunaxa setirostris* var. *plurisetosa* and *C. setirostris* var. *diversa* were described in "Mihelčič, F. 1958" but did not have the entire citation and had not seen the original description. The authors have also not been able to locate such a publication after extensive searching and so have not included the taxa here.

As suggested by Den Heyer (2011b), *Cunaxa boneti*, *C. denmarki*, *C. exoterica*, *C. floridanus*, *C. lehmanae*, *C. lukoschusi*, *C. metzi*, *C. myabunderensis*, *C. newyorkensis*, *C. rackae*, *C. reevesi*, and *C. reticulatus* are moved to *Rubroscirus* and *C. otiosus*, *C. valentis*, and *C. rasile* returned to *Rubroscirus* as they possess dorsal plates that are reticulated instead of smooth as in *Cunaxa*.

Cunaxa nankanaensis Bashir, Afzal, Ashfaq, Raza, Kamran, 2011 is considered a junior synonym and junior homonym of *Cunaxa nankanaensis* Bashir & Afzal, 2009.

1	Setae *lps* present (Figs 54a–d) **2**
–	Setae *lps* absent (Fig. 54e) ..... ***C. anomala* Khaustov & Kuznetzov, 1998**
2 (1)	Setae *at* normal, nearly as long as *pt* **3**
–	Setae *at* short and stubby, less than half the length of *pt* ..... ***C. anacardae* Gupta, 1992**
3 (2)	Basifemora I with 1 sts **4**
–	Basifemora I with 2 sts **5**
–	Basifemora I with 3 sts 7
–	Basifemora I with 4 sts **14**
–	Basifemora I with 5 sts **43**
4 (3)	Basifemora I–IV setal formula 1-2-3-0; telofemora I–IV setal formula 2-2-4-3; India ..... ***C. prinia* Gupta & Paul, 1985**
–	Basifemora I–IV setal formula 1-1-1-2; telofemora I–IV setal formula 2-2-1-1; India ..... ***C. magniferae* Gupta, 1992**
5 (3)	Basifemora II-IV setal formula 2-1-0 ..... **6**
–	Basifemora II-IV setal formula 3-3-1 ..... ***C. Dotos* Bashir & Afzal, 2009**
6 (5)	Tibia II with 5 sts; Pakistan ..... ***C. mahmoodi* Bashir & Afzal, 2009**
–	Tibia II with 7 sts; Pakistan ..... ***C. okaraensis***
7 (4)	Genua I with 3 solenidia **8**
–	Genua I with 4 solenidia **9**
8 (7)	Genua II with 1 solenidion; setae f_1, h_1 smooth (Fig. 55a) ..... ***C. setirostris* (Hermann, 1804)**
–	Genua II with 2 solenidia; setae f_1, h_1 spiculate (Fig. 55b) ..... ***C. magoebaensis* Den Heyer, 1979**
9 (7)	Coxae I–IV setal formula 3-1-3-2 sts **10**
–	Coxae I–IV setal formula 3-2-3-1 sts ..... ***C. eupatoriae* Chinniah & Mohanasundaram, 2001**

10 (9) Dorsal setae short (c_1–f_1, c_2: 7-10, h_1: 17) ..... ***C. mercedesae*** **Corpuz-Raros & Garcia, 1995**

– Dorsal setae longer (19-40) **11**

11 (10) Oval area formed by broken striae around setae *sci* present (Fig. 54a) ..... ***C. maculata*** **Sergeyenko, 2009**

– Oval area formed by broken striae around setae *sci* absent (Fig. 54b) **12**

12 (11) Genua II proximal solenidion extremely short, its length subequal to the diameter of its alveolus; ventral surface of the coxal region of hypognathum smooth ..... ***C. guanotoleranta*** **Sergeyenko, 2009**

– Genua II proximal solenidion long, its length several times longer than the diameter of its alveolus; ventral surface of the coxal region of the hypognathum with numerous papillae **13**

13 (12) Length of setae *sci* longer than half the distance between their bases; dorsal hysterosomal striae distinctly lobed (= with festoons) (Fig. 56a) ..... ***C. papuliphora*** **Sergeyenko, 2009**

– Length of setae *sci* shorter or equal to half the distance between their bases; dorsal hysterosomal striae smooth (Fig. 56b) . *C. gordeevae* Sergeyenko, 2009

14 (3) Basifemora III with 2 sts **15**

– Basifemora III with 3 sts **17**

– Basifemora III with 4 sts **41**

15 (14) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) ..... ***C. jatoiensis*** **Bashir & Afzal, 2006**

– Telofemoral apophysis straight, not uncinated **16**

16 (14) Basifemora IV with 1 sts; cheliceral longitudinal striations present (Fig. 57a) ..... ***C. heterostriata*** **Khaustov & Kuznetzov, 1998**

– Basifemora IV with 0 sts; cheliceral longitudinal striations absent (Fig. 57b) .... ***C. yaylensis*** **Sergeyenko, 2009**

17 (14) Basifemora IV with 0 sts ..... ***C. violaphila*** **Sergeyenko, 2009**

– Basifemora IV with 1 sts **18**

– Basifemora IV with 2 sts ..... ***C. brevicrura*** **Den Heyer, 1979**

– Basifemora IV with 5 sts ..... ***C. meiringi*** **Den Heyer, 1979**

18 (17) Median plate present (may be indistinctly defined) (Figs 58a–e) **19**

– Median plate absent (Fig. 58f) **36**

19 (18) Telofemoral apophysis uncinated (e.g., bent, hook-shaped) (Fig. 59a) **20**

– Telofemoral apophysis present or absent; if present, not uncinated (Figs 59b–e) **25**

20 (19) Setae c_1 not on hysterosomal shield, on integument **21**

– Setae c_1 on hysterosomal shield **22**

21 (20) Tibiae I with 3 asl, 4 sts; Pakistan ..... ***C. clusus*** **Bashir & Afzal, 2009**

– Tibiae I with 2 asl, 4 sts; Pakistan ..... ***C. nankanaensis***

22 (20) Setae f_1 on hysterosomal shield **23**

– Setae f_1 not on hysterosmal shield, on integument **24**

23 (22) Tibia III with 5 sts ..... ***C. leuros*** **Bashir, Afzal, Ashfaq, Akbar & Ali 2010**

– Tibia III with 6 sts..... ***C. rafiqi*** **Bashir, Afzal, Ashfaq, Akbar & Ali 2010**
24 (22) Genua I with 2 asl, 5 sts..... ***C. capreolus*** **(Berlese, 1887)**
– Genua I with 3 asl, 3 sts; tibia I with 2 asl, 4 sts; Pakistan..... ***C. pakpatanensis***
– Genua I with 3 asl, 4 sts; tibia I with 2 asl, 4 sts; Pakistan..... ***C. bashiri*** **Bashir & Afzal, 2009**
25 (19) Telofemoral apophysis truncated (Fig. 59b)..... ***C. carina*** **Den Heyer, 1979**
– Telofemoral apophysis not truncated (Figs 59c–e) **26**
26 (25) Line of small sharp spines on pedipalp tibiotarsi present (Fig. 60a)..... ***C. dentata*** **Sergeyenko, 2003**
– Line of small sharp spines on pedipalp tibiotarsi absent (Fig. 60b)..... **27**
27 (26) Median plate complemented with c_2 (Figs 58a–d)..... **28**
– Median plate not complemented with c_2 (Fig. 58e)... ***C. terrula*** **Den Heyer, 1979**
28 (27) Median plate indistinctly defined (Fig. 58a)..... **29**
– Median plate distinctly defined (Fig. 58b–d) **30**
29 (28) Setae f_1, h_1 smooth ..... ***C. romblonensis*** **Corpuz-Raros & Garcia, 1995**
– Setae f_1, h_1 finely setose..... ***C. sordwanaensis*** **Den Heyer, 1979**
30 (28) Median shield complemented with c_1, d_1, c_2 (Fig. 58b) ..... ***C. sudakensis*** **Khaustov & Kuznetzov, 1998**
– Median shield complemented with c_1–e_1, c_2 (Fig. 58c, d) **31**
31 (30) Coxae IV with 1 sts..... **32**
– Coxae IV with 2 sts..... **33**
32 (31) Broken striae that form cell-like structures on median shield present (Fig. 58c)..... ***C. thailandicus*** **Smiley, 1992**
– Broken striae that form cell-like structures on median shield absent (Fig. 58d)..... ***C. veracruzana*** **Baker & Hoffmann, 1948**
33 (31) Setae c_1 longer than all other dorsal setae..... ***C. womersleyi*** **Baker & Hoffmann, 1948**
– Setae c_1 not longer than all other dorsal setae **34**
34 (33) Genua I–IV with 4-2-1-1 solenidia..... ***C. lamberti*** **Den Heyer, 1979**
– Genua I–IV with 3-1-1-1 solenidia..... **35**
35 (34) Setae c_1–h_1 approximately equal in length ... ***C. hermanni*** **Den Heyer, 1979**
– Setae c_1–e_1 half as long as f_1, h_1 ..... ***C. thessalica*** **Sionti & Papadoulis, 2003**
36 (18) Telofemoral apophysis uncinated (Fig. 59a)..... **37**
– Telofemoral apophysis not uncinated (Fig. 59b-e) **38**
37 (36) Genua I–IV setal formula 1 asl, 6 sts-7-6-6; Philippines ..... ***C. pantabanganensis*** **Corpuz-Raros & Garcia, 1995**
– Genua I–IV setal formula 1 asl, 4 sts-5-6-6; Pakistan..... ***C. lodhranensis*** **Bashir & Afzal, 2009**
38 (36) Proterosomal shield striated (Fig. 54c) **39**
– Proterosomal shield smooth (Fig. 54d) ..... ***C. potchensis*** **Den Heyer, 1979**
39 (38) Setae f_1, h_1 smooth (Fig. 55a) **40**
– Setae f_1, h_1 spiculate (Fig. 55b) ..... ***C. gazella*** **(Ewing, 1913)**

40 (39) Pedipalp telofemoral apophysis short and cone-like (Fig. 59c) ..... ***C. mageei* Smiley, 1992**

– Pedipalp telofemoral apophysis short and finger-like (Fig. 59d) ..... ***C. neogazella*, Smiley, 1992**

41 (14) Median plate present (Fig. 58d); basifemora IV with 1 sts ..... ***C. luzonica* Corpuz-Raros & Garcia, 1995**

– Median plate absent (Fig. 58f); basifemora IV with 1 or 2 sts **42**

42 (41) Basifemora IV with 1 sts ..... ***C. cogonae* Corpuz-Raros & Garcia, 1995**

– Basifemora IV with 2 sts ..... ***C. doxa* Chaudhri, 1980**

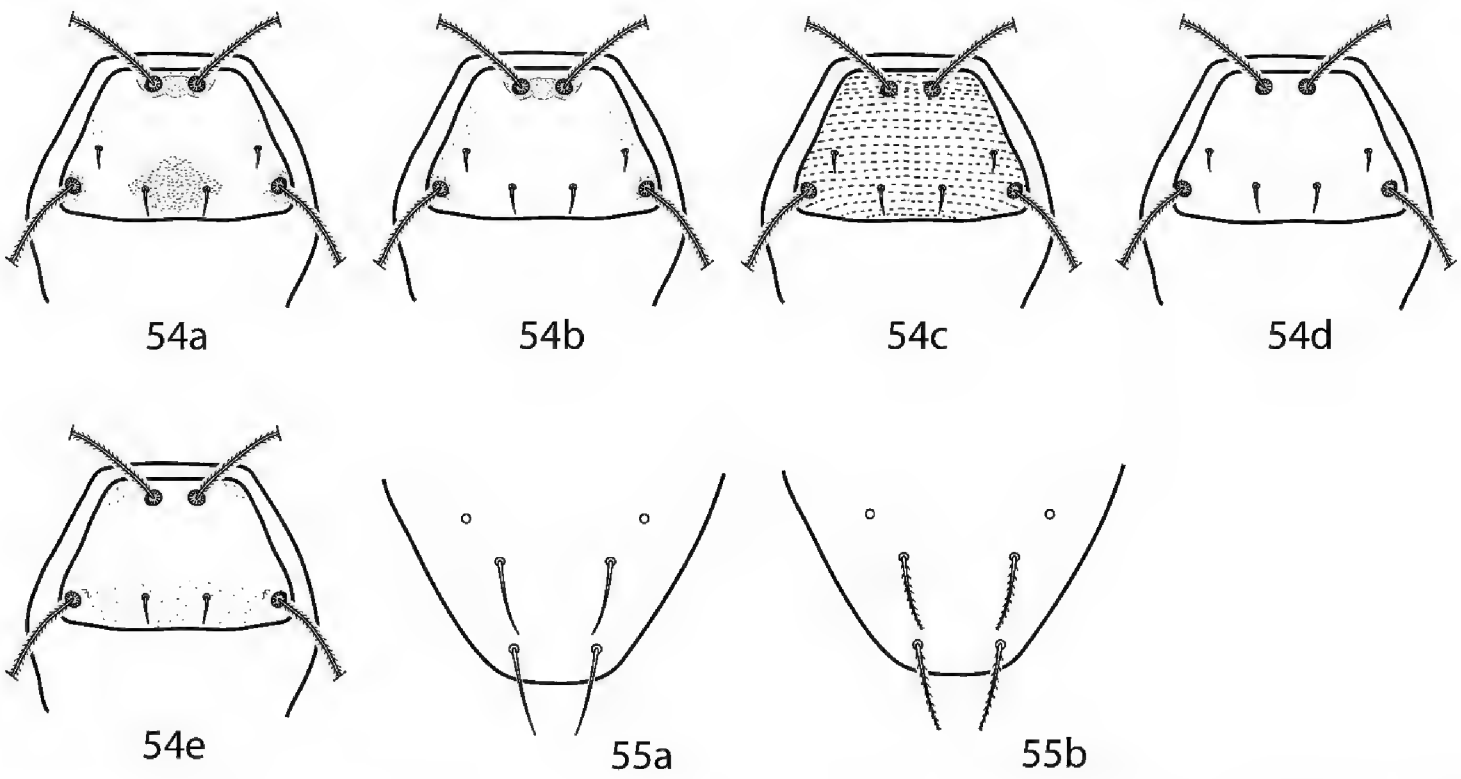
43 (3) Basifemora III with 4 sts ..... ***C. evansi* Smiley, 1992**

– Basifemora III with 6 sts ..... ***C. grobleri* Den Heyer, 1979**

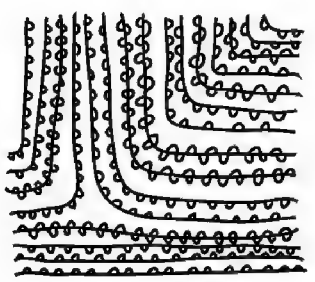
Cunaxatricha Castro & Den Heyer, 2008

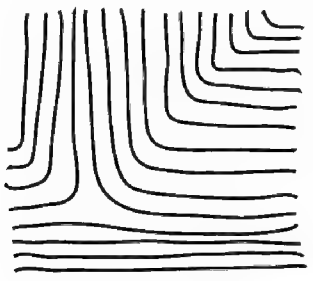
Historical review. Castro and Den Heyer (2008) erected *Cunaxatricha* for *C. tarsospinosa*.

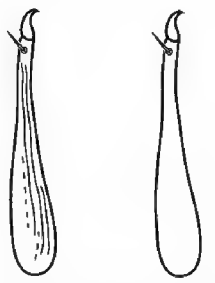
Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and end in a strong claw. They extend beyond the subcapitulum by at least the last segment; apophyses absent. Basifemora complemented with a long simple seta; telofemora complemented with a short simple seta. These two segments fused, although a line remains visible and they can thus be differentiated. Subcapitulum complemented with 6 pairs of setae (hg_{1-4} and 2

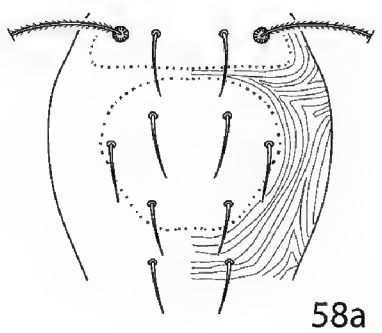


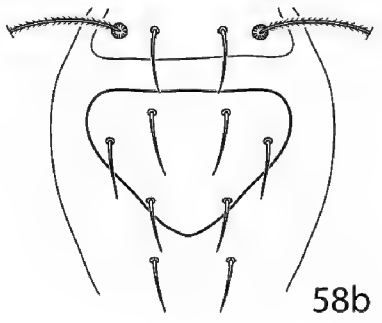
Figures 54, 55. *Cunaxa* key illustrations. **54a–e** Proterosomal shield, dorsal **54a** Proterosomal shield with oval area formed by broken striae around *pt* present, *mps* present **54b** Proterosomal shield with oval area formed by broken striae around *pt* absent, *mps* present **54c** Proterosomal shield striated, *mps* present **54d** Proterosomal shield smooth, *mps* present **54e** Proterosomal shield with *lps* absent **55a** Smooth f_1, h_1 **55b** Spiculate f_1, h_1.


56a


56b


57a 57b


58a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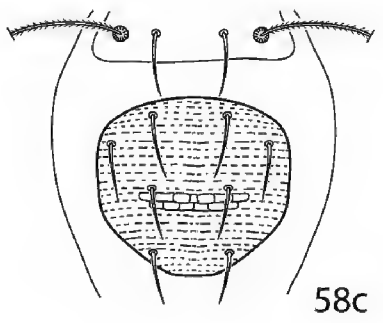
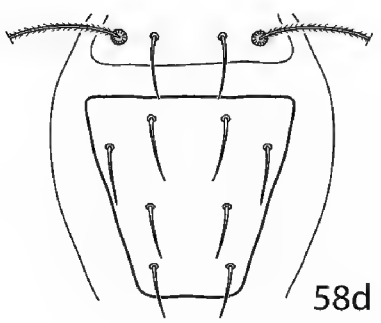

58c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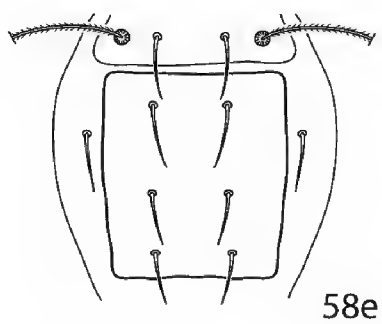
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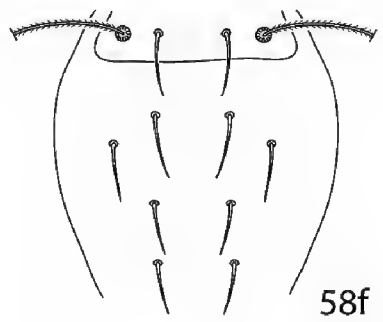
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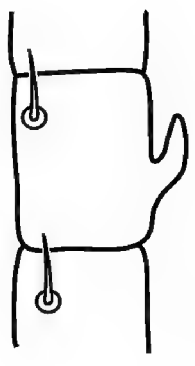
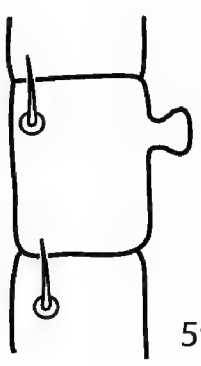
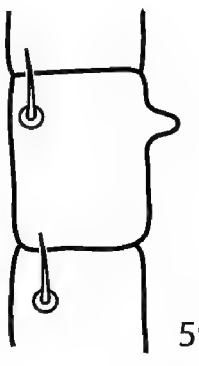
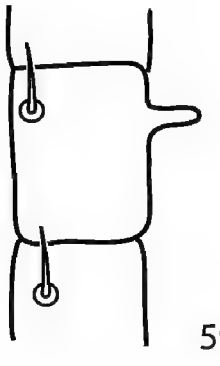
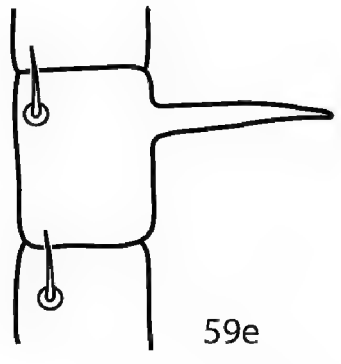
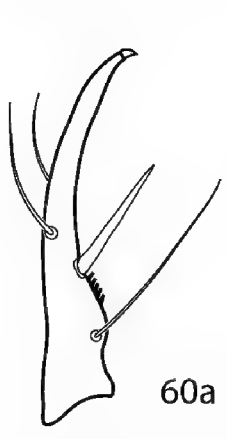

59a


59b


59c


59d


59e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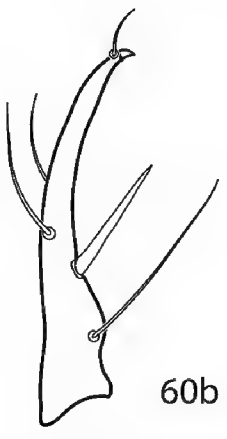

60b

Figures 56–60. *Cunaxa* key illustrations. **56a, b** Integumental striations **57a** Chelicera with longitudinal striations present **57a** Chelicera with longitudinal striations absent **58a–f** Examples of variation in the hysterosomal median plate **59a** Pedipalp telofemoral apophysis uncinated **59b** Pedipalp telofemoral apophysis truncated **59c** Pedipalp telofemoral apophysis short and cone-like **59d** Pedipalp telofemoral apophysis short and finger-like **59e** Pedipalp telofemoral femoral apophysis long **60a** Pedipalp tibiotarsus with small teeth present **60b** Pedipalp tibiotarsus with small teeth absent.

pairs of adoral setae). Setae hg_4 located between hg_{2-3} instead of in the coxal region. **Chelicera** with seta present.

Idiosoma, dorsal. Female dorsal idiosoma bears a sclerotized shield that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). Idiosomal shield reticulated. 7 pairs of setae, c_{1-2}, d_1–h_1, present. Cupule *im* present, usually posteriolaterad of e_1. Integument striated.

Idiosoma, ventral. **Coxae** I and II fused, as are coxae III and IV. 6 pairs of setae present between and posterior to the coxae. Genital plates each bear 4 setae; 2 pairs of genital papillae not visible underneath the plates. Integument between plates striated and bears 4 pairs of additional setae. **Legs** shorter than the body. Leg 4 longest. Famulus on tarsi I normally shaped and set in a deep depression. Tarsi slightly constricted apically, resulting in small tarsal lobes. Basifemora and telofemora of legs I and II partially fused. A trichobothrium on leg tibia IV absent. Ambulacral claws on either side of a 4-rayed empodium present.

Dactyloscirus Den Heyer, 1978

Historical review. Trägårdh (1905) described *Scirus inermis*. Berlese (1916) erected *Dactyloscirus* as a subgenus of *Scirus* to accommodate *Scirus* (*Dactyloscirus*) *eupaloides*. He also described *Scirus dorcas* but failed to recognize that they were congeneric. Oudemans (1922) described *Rosenhofia machairodus*. Halbert (1923) redescribed and figured *S. inermis* from Ireland. Sellnick (1926) transferred *S. inermis* to *Cunaxa*. Vitzthum (1931) raised *Dactyloscirus* to full generic status but later (1940-43) treated it as a subgenus. Thor and Willmann (1941) again elevated *Dactyloscirus* to generic status and designated *Dactyloscirus eupaloides* as the type specimen; they also transferred *C. inermis* and *S. dorcas* to *Dactyloscirus*. Baker and Hoffmann (1948) regarded *Dactyloscirus* as a senior synonym of *Cunaxa*. Smiley (1975) synonymized *Rosenhofia* with *Dactyloscirus*. Zaher et al. (1975b) reported *D. inermis* from Egypt (though they called it *Cunaxa inermis*). Den Heyer (1978a) split *Armascirus* from *Dactyloscirus* and *Cunaxa* and raised the subfamily Cunaxinae to accommodate them, thus refining the definitions of all three genera. Den Heyer (1979a) described *D. condylus* and *D. dolichosetosus*. Den Heyer (1980c) erected the tribe *Armascirini* and made *Dactyloscirus* and *Armascirus* the sole representatives. Gupta and Ghosh (1980) described *Cunaxoides nicobarensis*. *Dactyloscirus pataliputraensis* was described by Gupta (1981). Liang (1986) described *D. humuli* from China. Shiba (1986) described *D. mesonotus*. Michocka (1987) reported *D. inermis* from Poland. Smiley (1992) transferred *Cunaxoides nicobarensis* to *Dactyloscirus* (though see discussion below) and described *D. mansoni*, *D. johnstoni*, and *D. poppi*. Gupta (1992) described *D. bengalensis*. Corpuz-Raros (1995) described *D. philippinensis*, *D. rosarioae*, and *D. agricolus*. Inayatullah and Shahid (1996) described *D. illutus*, *D. minys*, and *D. orsi*. Swift (1996) described *D. hoffmannae* and *D. smileyi* from the Hawaiian Islands. Hu (1997) reported *D. inermis* and *D. humuli* from China. Bashir and Afzal (2006a) described *D. imbecillus* and *D. manzoori*. Bashir, Afzal, and

Akbar (2005) described *D. kahrorensis*. Corpuz-Raros (2008) described *D. discocondylus* and *D. trifidus*. Skvarla and Dowling (2012) described *D. pseudophilippinensis*. Den Heyer and Castro (2012) described *D. saopauloensis*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented, extend beyond the subcapitulum by at least the last segment, and end in a strong claw. An apophysis between the genua and tibiotarsi usually present. This apophysis long or short and generally ends in a bulbous, hyaline tip; it can, however, end in a tapering point as in *Armascirus*. This apophysis approximately equal between males and females or shorter in males. Basifemora and telofemora complemented with spine-like setae; these two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae) and covered by integumental papillae that are either randomly distributed or form a polygonal, reticulated pattern.

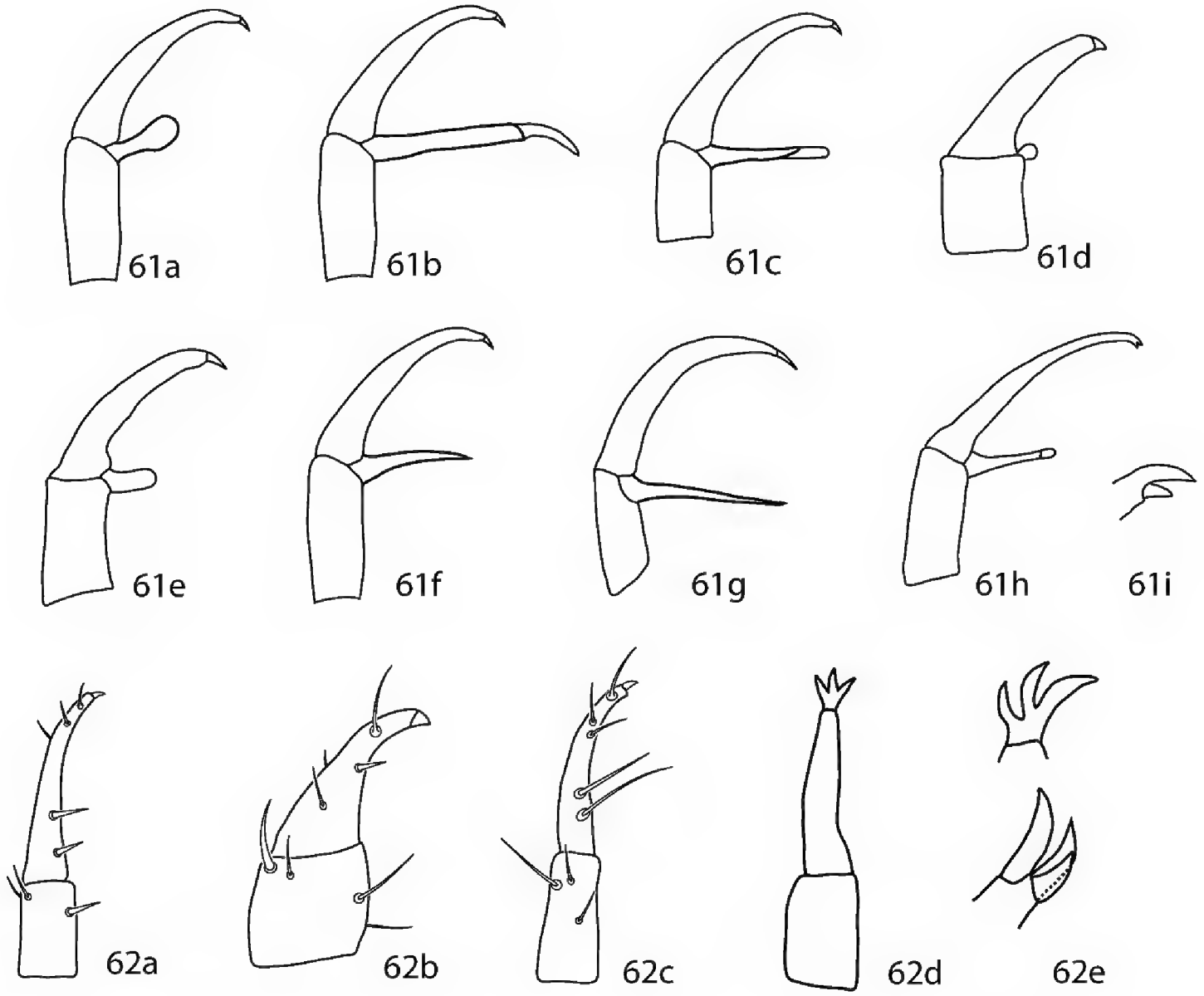
Idiosoma, dorsal. Female dorsal idiosoma has at least one sclerotized plate that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). 0–4 other major plates and platelets present. All plates, if present, covered by integumental papillae that form a reticulated pattern. Integument between plates striated. 7 pairs of setae ($c_{1–2}$, d_1–h_1) present. Each seta, when not on a major plate or platelet, surrounded by a minute platelet only slightly larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of e_1. Dorsal idiosoma of males similar except a single large plate complemented with $c_{1–2}$, d_1–e_1 present.

Idiosoma, ventral. **Coxae** I and II often fused; coxae III and IV often fused. Setal formula for coxae I–IV 3-3-3-3 (including paracoxal seta). Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (ps_1). 2 pairs of setae (ps_2 and h_2) associated with, but do not occur on, anal plates. Cupule *ih* present in close proximity to h_2. Integument between plates striated and bears 5–7 pairs of additional setae. Ventral idiosoma of males similar except the coxae much more extensive. A sclerotized aedeagus often visible in association with the genital plates. **Legs** comparatively short, generally not exceeding ¾ the length of the body. Famulus on tarsi I enlarged and ends in a tri-tipped prong. Tarsi constricted apically, resulting in large tarsal lobes. Trichobothrium on leg tibia IV present. Ambulacral claws occur on either side of a 4-rayed empodium.

Key to adult female *Dactyloscirus* (modified from Skvarla and Dowling 2012)

Smiley (1992) transferred *Cunaxoides nicobarensis* to *Dactyloscirus* as *D. nicobarensis* (Gupta & Ghosh, 1980). However, later in the same work he attributes the same holotype (No. 3146/17) and same description (viz. Gupta and Ghosh 1980:191) to *Cunaxoides nicobarensis* Gupta & Ghosh, 1980. The original description and illustration by Gupta and Ghosh clearly state the species in question has three pedipalpal segments, which precludes it from being assigned to *Dactyloscirus*. Smiley illustrated a *Dactyloscirus* with 5-segmented pedipalp "after Gupta and Ghosh 1980" when discussing *D. nicobarensis*, though it looks like nothing in the publication. Because of this *Dactyloscirus nicobarensis* (Gupta and Ghosh 1980) is declared *nomen dubium*.

1	Pedipalpal tibiotarsi and genua with adjoining apophyses present (Figs 61a–i) ... **2**
–	Pedipalpal tibiotarsi and genua with adjoining apophyses absent (Figs 62a–d) ... **21**
2 (1)	Dorsal hysterosomal lateral platelets present (Figs 63a–d) ... **3**
–	Dorsal hysterosomal lateral platelets absent (Figs 64a–f) ... **15**
3 (2)	Pedipalp telofemora with one or two apophyses (Figs 65a–c) ... **4**
–	Pedipalp telofemora without an apophysis; distribution unknown ... ***D. poppi* Smiley, 1992**
4 (3)	Pedipalpal telofemora with 1 apophysis (Figs 65a, b) ... **5**
–	Pedipalpal telofemora with 2 apophyses: 1 basal, flattened and disc-shaped, 1 apical, short, thick and bulbous (Fig. 65c); South Africa ... ***D. condylus* Den Heyer, 1979**
5 (4)	Lateral platelets inconspicuous, length less than 2 times the length of c_1 or c_2; cosmopolitan (Fig. 63a) ... ***D. inermis* (Trägårdh 1905)**
–	Lateral platelets large, length greater than 2 times the length of c_1 or c_2 (Figs 63b–d) ... **6**
6	(5) Dorsal setae f_1 and h_1 equal in length; median shield present (Figs 63b,c) or absent (Fig. 63d) ... **7**
–	Dorsal setae f_1 shorter than h_1; median shield absent (Fig. 63d) ... **11**
7	(6) ... Apophysis adjoining pedipalpal genua and telofemora shorter than length of genu, blunt distally (Fig. 61a); median shield absent (Fig. 63d) ... **8**
–	Apophysis adjoining pedipalpal genua and telofemora as long or longer than length of genu, blunt or pointed distally (Fig 61 c); median shield present or absent(Figs 63b, c) ... **10**
8 (7)	Median shield present ... **9**
–	Median shield absent; Japan ... ***D. mesonotus* Shiba, 1986**
9 (8)	Coxa IV with 2 sts; Pakistan ... ***D. manzoori* Bashir & Afzal, 2006**
–	Coxa IV with 3 sts; South Africa ... ***D. dolichosetosus* Den Heyer, 1979**
10 (7)	Apophysis adjoining pedipalpal genua and telofemora pointed distally (Fig 61b); pedipalp tibiotarsi with 4 sts; median shield complimented with setae c_1, d_1; e_1 on small platelets (Fig. 63b); leg basifemora with 5-5-3-1 sts; Luzon I., Philippines ... ***D. philippinensis* Corpuz-Raros, 1995**
–	Apophysis adjoining pedipalpal genua and telofemora blunted distally (Fig. 61c); setae c_1–e_1 on median shield (Fig. 63c); pedipalp tibiotarsi with 5 sts; leg basifemora with 5-5-3-2 sts; Ozark Mountains, USA ... ***D. pseudophilippinensis* Skvarla & Dowling, 2012**
11 (6)	Apophysis adjoining pedipalpal genua and telofemora inconspicuous: circular, minute and hyaline (Fig. 61d); Oahu I., Hawaiian Islands ... ***D. hoffmannae* Swift, 1996**
–	Apophysis adjoining pedipalpal genua and telofemora conspicuous, blunt apically (Fig. 61e) ... **12**
12 (11)	Coxa IV with 2 sts ... **13**
–	Coxae IV with 3 sts ... **14**



Figures 61–62. *Dactyloscirus* key illustrations. **61a–h** Pedipalp genu and tibiotarsus with adjoining apophysis present **61i** Close up of bifid claw **62a–d** Pedipalp genu and tibiotarsus with adjoining apophysis absent **62e** Close up of trifid claw.

13 (12) Tibiae I with 1 asl, 4 sts; tibiae III with 1 asl, 5 sts..... .....***D. kahrorensis*** **Bashir, Afzal & Akbar, 2006**

– Tibiae I with 2 asl, 4 sts; tibiae III with 2 asl, 4 sts..... .....***D. imbecillus*** **Bashir & Afzal, 2006**

14 (12) Genital setae g_3 longest, 1.5–1.7 times the length of g_2 and g_4, more than 2 times the length of g_1; Kauai I., Hawaiian Islands .....***D. smileyi*** **Swift, 1996**

– Genital setae g_4 longest, 2 times the length of $g_{1–3}$; Shanghai, China..... ..... ***D. humuli*** **Liang, 1986**

15 (2) Dorsal hysterosomal median shield present (Figs 64a–e).....**16**

– Dorsal hysterosomal median shield absent (Fig. 64f) **18**

16 (15) Median shield complemented with c_1,d_1 (Fig. 64b); apophysis adjacent to pedipalpal genua and tibiotarsi blunt distally (Fig. 61c); Mexico, Philippines... .....***D. mansoni*** **Smiley, 1992**

– Median shield complemented with c_1–e_1 (Figs 64c,d); apophysis adjacent to pedipalpal genua and tibiotarsi blunt or pointed distally.....**18**

– Median shield complemented with c_1–e_1, c_2 (Fig. 64e); apophysis adjacent to pedipalpal genua and tibiotarsi pointed distally ..... ***D. illutus*** **Inayatullah & Shahid, 1996**

17 (18) Apophysis adjacent to pedipalpal genua and tibiotarsi blunt distally (Fig. 61e); median shield triangular and nearly as wide as proterosomal shield (Fig. 64c); Bihar, India..... ***D. pataliputraensis*** **Gupta, 1981**

– Apophysis adjacent to pedipalpal genua and tibiotarsi tapering and pointed distally (Fig. 61f); median shield subrectangular and not as wide as proterosomal shield (Fig. 64d); Mexico..... ***D. johnstoni*** **Smiley, 1992**

18 (17) Pedipalpal telofemora without apophysis (Fig. 61g); apophysis adjoining pedipalpal genua and telofemora longer than telofemora and tapering to a point; Sumatra, Indonesia..... ***D. machairodus*** **(Oudemans, 1922)**

– Pedipalpal telofemora with 1 or 2 apophyses (Figs 65a–d); apophysis adjoining pedipalpal genu and telofemur shorter than telofemora and with a bulbus tip (Fig. 61a, d)..... **19**

19 (18) Pedipalpal telofemora with 1 apical apophysis (Figs 65a,b); apophysis adjoining genua and tibiotarsi larger (Fig. 61a)..... **20**

– Pedipalpal telofemora inner surface with 2 apophyses: 1 basal, flattened and disc-shaped, 1 apical, short, thick and bulbous (Fig. 65d); apophysis adjoining genua and tibiotarsi small, inconspicuous (Fig. 61d); Luzon I., Philippines..... ***D. discocondylus*** **Corpuz-Raros, 2008**

20 (19) Basal pair of adoral setae very long, more than 4 times the distal pair; pedipalp telofemoral apophysis about as long as width of segment (Fig. 65a); genital setae g_4 twice as long as g_1–g_3; Luzon I., Philippines ... ***D. rosarioae*** **Corpuz-Raros, 1995**

– Basal pair of adoral setae not unusually long, subequal to distal pair; pedipalp telofemoral apophysis short, less than width of segment (Fig. 65b); genital setae g_4 only slightly longer than g_1–g_3; Luzon I., Philippines ..... ***D. agricolus*****, Corpuz-Raros, 1995**

21 (1) Median shield present (Figs 64d,e)..... **22**

– Median shield absent (Fig. 64f) **23**

22 (21) Median shield complimented with c_1–e_1 (Fig. 64d); Europe, North and South America ..... ***D. eupaloides*** **Berlese, 1916**

23 (21) Coxa I with 2 sts; Pakistan..... ***D. bengalensis*** **Gupta, 1992**

– Coxa I with 3 sts..... **24**

24 (23) Pedipalp tibiotarsal claw trifid (Fig. 62c,d); coxa II–IV setal formula 3-3-3 sts; Luzon I., Philippines..... ***D. trifidus*** **Corpus-Raros, 2008**

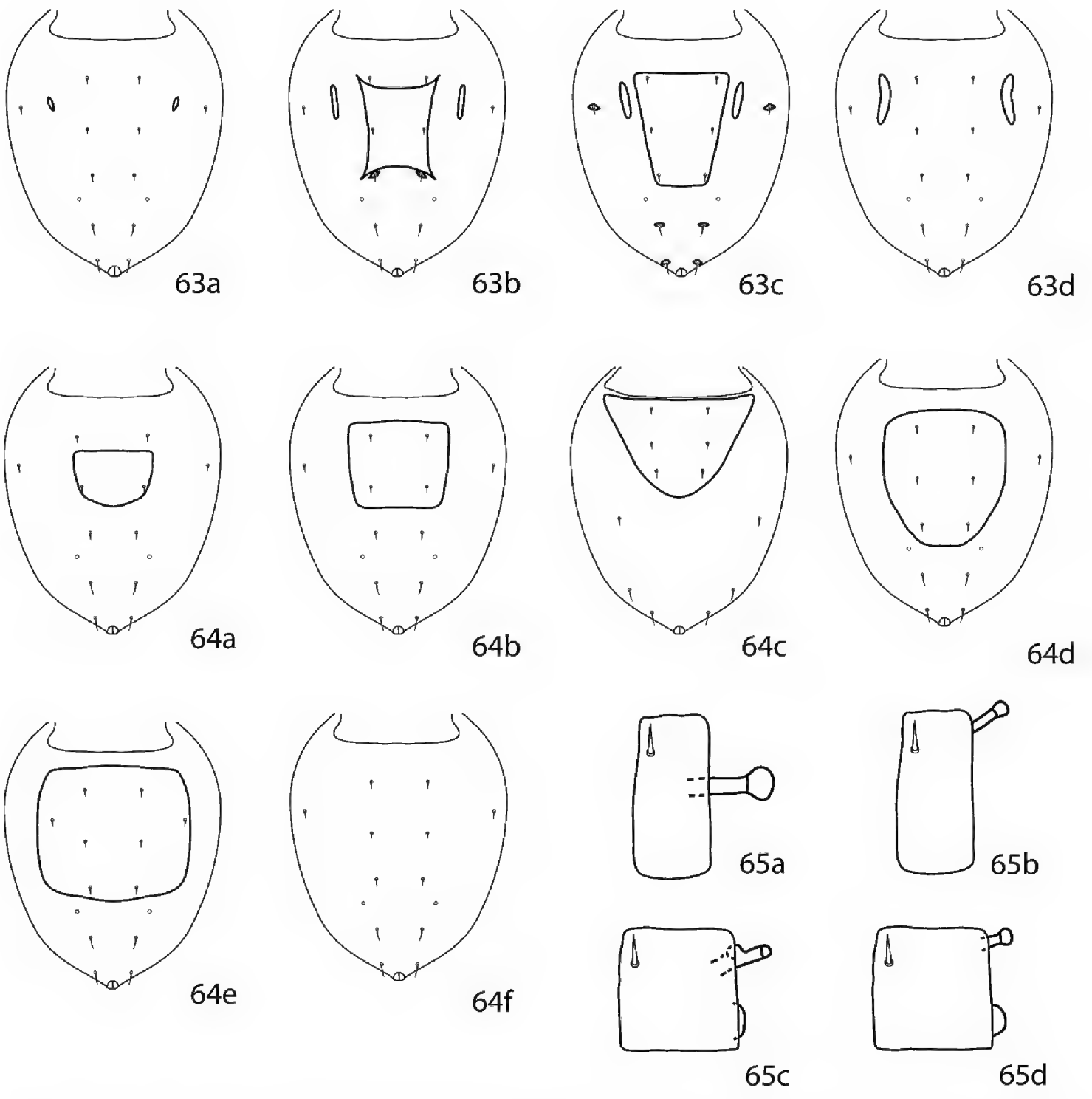
– Pedipalp tibiotarsal claw entire, unbranched (Fig. 62a, b); coxa II–IV setal formula not as above..... **25**

25 (24) Coxal setal formula II–IV 1-3-2 sts; Peshawar, Pakistan ..... ***D. orsi*** **Inayatullah & Shahid, 1996**

– Coxal setal formula II–IV 2-3-1 sts; Brazil..... ***D. saopauloensis*** **Den Heyer & Castro, 2012**

Riscus Den Heyer, 2006

Historical review. Gupta and Ghosh (1980) described *Cunaxa bambusae*, *C. cynodonae* Den Heyer (2006) erected *Riscus* for *R. thailandensis*. Den Heyer (2011) transferred *C. bambusae* and *C. cynodonae* to *Riscus* based on the redescriptions by Corpuz-Raros (2008). Den Heyer and Castro (2012) described *R. austroamericanus*.



Figures 63–65. *Dactyloscirus* key illustrations. **63a–d** Dorsal idiosoma, lateral hysterosomal platelets present **64a–f** Dorsal idiosoma, lateral hysterosomal platelet absent **65a** Pedipalp telofemur with one apophysis, which is about as long as the width of the telofemur **65b** Pedipalp telofemur with one apophysis, which is shorter than the width of the telofemur **65c, d** Pedipalp telofemur with two apophyses, one apical and one basal which is flattened and disc-shaped.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented, extend beyond the subcapitulum by at least the last segment, and end in a strong claw; apophysis absent. Basifemora and telofemora complemented with simple setae; these two segments fused, although a line remains visible and they can thus be differentiated. **Subcapitulum** complemented with 6 pairs of setae ($hg_{1–4}$ and 2 pairs of adoral setae). Setae hg_3 and hg_4 both near the coxal bases of the pedipalps.

Idiosoma, dorsal. Female dorsal idiosoma has a sclerotized plate that bears 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of simple setae (*lps* and *mps*). Idiosomal shield covered by integumental papillae that form a reticulated pattern. Hysterosoma lacks a plate and bears 7 pairs of setae ($c_{1–2}$, d_1–h_1). Cupule *im* present, usually laterad or in the proximity of e_1.

Idiosoma, ventral. **Coxae** ill-defined. Coxae I and II fused; coxae III and IV fused. Coxae I–IV setal formula 3-1-3-1 (including paracoxal seta). Genital plates each bear 4 setae. Anal plates bear 1 pair of setae (ps_1). 2 pairs of setae (ps_2 and h_2) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to h_2. Integument between plates striated and bears 5 pairs of additional setae. **Legs.** Ambulacral claws on either side of a 4-rayed empodium present.

Key to adult female *Riscus* (modified from Den Heyer and Castro 2012)

1	Five pairs of genital setae..... ***R. austroamericanus* Den Heyer & Castro, 2008**
–	Four pairs of genital setae; tibiae IV with 1 T, 4 sts; tibiae II with {1 asl, 1 sts}, 4 sts **2**
2 (1)	Pedipalpal genu with 3 sts..... **3**
–	Pedipalpal genu with 4 sts..... ***R. bambusae* (Gupta & Ghosh 1980)**
3 (2)	Pedipalpal tibiotarsus with 1 spls, 3 sts, 1 dorsoterminal solenidion..... ***R. thailandensis* Den Heyer, 2006**
–	Pedipalpal tibiotarsus with 5 sts, 1 dorsoterminal solenidion (original description states 6 sts present; one of these is assumed to be a solenidion here) ..... ***R. cynodonae* (Gupta & Ghosh, 1980)**

Rubroscirus Den Heyer, 1979

Historical review. Baker and Hoffmann (1948) described *Cunaxa boneti*. Den Heyer (1979d) erected *Rubroscirus*, described *R. africanus*, *R. rarus*, and *R. vestus*, and transferred *C. boneti* to the the genus. Tseng (1980) desbribed *Cunaxa exoterica*. Muhammad, Chaudhri, and Akbar (1989) described *R. valentis*. Smiley (1992) synonymized *Rubroscirus* with *Cunaxa* and described *C. denmarki*, *C. floridanus*, *C. lehmanae*, *C. lukoschusi*, *C. metzi*, *C. newyorkensis*, *C. rackae*, and *C. reevesi*. Fan (1992) described *R. denheyeri* and *R. sinensis*. Muhammad and Chaudhri (1993) described *R. rasile* and *R. otiosus*. Corpuz-Raros and Garcia (1995) described *C. venusae* and *C. viscayana*. Bashir, Afzal, and Ali (2005) described *Cunaxa reticulatus*

and transferred *R. valentis*, *R. rasile*, and *R. otiosus* to *Cunaxa*. Sergeyenko (2006) recognized *Rubroscirus* as a valid genus and described *R. khaustovi*. Ferla and Rocha (2012) described *R. nidorum*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiae. An apophysis on the telofemora present. Stout spine-like seta on the genua and tibiotarsi setae present or absent. Tibiotarsi end in a strong claw. **Subcapitulum** with 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (hg_{1-4}). Subcapitulum is reticulated.

Idiosoma, dorsal. Proterosoma bears a shield, complemented with 2 pairs of setose sensillae (*at* and *pt*) and 2 pairs of setae (*lps* and *mps*). Sensillae *at* and *pt* not as densely pilose as in *Allocunaxa*, *Cunaxatricha*, and *Riscus*. Proterosomal shield reticulated. Hysterosomal shield absent in females. Lateral platelets (as in *Armascirus* and *Dactyloscirus*) absent. Setae c_1–h_1, and c_2 present. Cupule *im* present laterad and caudally of e_1. Integument not bearing the l shield striated. Striations papillated, not smooth or lobed as in *Cunaxa*.

Idiosoma, ventral. Coxae I–II may be fused; coxae III–IV may be fused. Coxae II–IV setal formula 1-3-1. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear 1 pair of setae (ps_1). 1 pair of setae (h_2) associated with, but do not occur on, the anal plates. Cupule *ih* present in close proximity to h_2. Integument between plates striated and bears up to 7 pairs of additional setae. **Legs.** Tarsi long and slender, and constricted distally but tarsal lobes small and not conspicuous as in *Armascirus* and *Dactyloscirus*. A trichobothrium on tibia IV present. Ambulacral claws either side of a 4-rayed empodium present.

Key to adult female *Rubroscirus*

Rubroscirus is recognized as a valid genus. As suggested by Den Heyer (2011b) *Cunaxa boneti*, *C. denmarki*, *C. exoterica*, *C. floridanus*, *C. lehmanae*, *C. lukoschusi*, *C. metzi*, *C. newyorkensis*, *C. rackae*, *C. reevesi*, *C. reticulatus*, *C. venusae* and *C. viscayana* are transferred to *Rubroscirus* as they possess reticulated proterosomal shields.

1	Basifemora I with 3 sts	**2**
–	Basifemora I with 5 sts	***R. denmarki*** **(Smiley, 1992)**
2 (1)	Basifemora III with 1 sts	**3**
–	Basifemora III with 2 sts; Pakistan	***R. reticulatus*** **Bashir, Afzal & Ali, 2006**
3 (2)	Basifemora IV with 1 sts	**4**
–	Basifemora IV with 2 sts; Mexico, Central America, USA	***R. boneti*** **(Baker & Hoffmann, 1948)**
4 (3)	Coxae I with 2 sts; Taiwan	***R. exoterica*** **(Tseng, 1980)**
–	Coxae I with 3 sts	**5**
5 (4)	Coxae II with 1 sts	**6**
–	Coxae II with 2 sts	**16**
6 (5)	Coxae IV with 1 sts	7
–	Coxae IV with 2 sts	**12**
7 (6)	Genua I with 1 asl, 5 sts; Ukraine	***R. khaustovi*** **Sergeyenko, 2006**

–	Genua I with 2 asl, 4 or 6 sts **8**
–	Genua I with 3 asl, 5 or 6 sts **10**
–	Genua I with 3 asl, 1 bsl, 5 sts; Pakistan ..... ***R. rasile*** **Chaudhri, 1993**
8 (7)	Genua I with 2 asl, 4 sts; genua IV with 1 asl, 5 sts **9**
–	Genua I with 2 asl, 6 sts; genua IV with 2 asl, 5 sts; USA ..... ***R. newyorkensis*** **(Smiley, 1992)**
9 (8)	Genua II with 1 asl, 5 sts; China ..... ***R. denheyeri*** **Fan, 1992**
–	Genua II with 1 asl, 6 sts; Brazil ..... ***R. nidorum*** **Ferla & Rocha, 2012**
10 (7)	Genua I with 5 sts; genua II with 1 asl, 5 sts; USA ..... ***R. lehmanae*** **(Smiley, 1992)**
–	Genua I with 6 sts; genua II with 2 asl, 5 or 6 sts **11**
11 (10)	Genua II with 2 asl, 5 sts; Pakistan ..... ***R. valentis*** **Muhammad, Chaudhri & Akbar, 1989**
–	Genua II with 2 asl, 6 sts; Pakistan ..... ***R. otiosus*** **Muhammad & Chaudhri, 1993**
12 (6)	Genua I with 7 sts; Phillipines .... ***R. viscayana*** **Corpuz-Raros & Garcia, 1995**
–	Genua I with 2 asl, 5 or 6 sts **13**
–	Genua I with 3 asl, 4 sts; China ..... ***R. sinensis*** **Fan, 1992**
–	Genua I with 4 asl, 5 sts; USA ..... ***R. floridanus*** **(Smiley, 1992)**
13 (12)	Genua I with 2 asl, 5 sts; genua II with 2 asl, 5 sts; genua IV with 1 asl, 5 sts ... **14**
–	Genua I with 2 asl, 6 sts; genua II with 6 sts; genua IV with 6 sts; Philippines ..... ***R. venusae*** **Corpuz-Raros & Garcia, 1995**
14 (13)	Genua III with 1 asl, 5 sts; setae c1, c2, d1, e1, f1, and h1 smooth **15**
–	Genua III with 2 asl, 5 sts; setae c1, c2, d1, e1, f1, and h1 spiculate; Costa Rica ..... ***R. rackae*** **(Smiley, 1992)**
15 (14)	Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibiotarsus present; New Zealand ..... ***R. reevesi*** **(Smiley, 1992)**
–	Minute thorn-like seta adjacent to median spine-like seta on pedipalp tibiotarsus absent; USA ..... ***R. metzi*** **Smiley, 1992**
16 (5)	Basifemora I with 1 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa ..... ***R. africanus*** **Den Heyer, 1979**
–	Basifemora I with 2 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 2 asl, 5 sts **17**
–	Basifemora I with 3 asl, 5 sts; basifemora II with 1 asl, 5 sts; basifemora III with 1 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa ..... ***R. vestus*** **Den Heyer, 1979**
–	Basifemora I with 4 asl, 5 sts; basifemora II with 2 asl, 5 sts; basifemora III with 2 asl, 5 sts; basifemora IV with 1 asl, 5 sts; South Africa... ***R. rarus*** **Den Heyer, 1979**
17 (16)	Setae c1, c2, d1, e1, f1, and h1 smooth; India ..... ***R. myabunderensis*** **(Gupta & Ghosh, 1980)**
–	Setae c1, c2, d1, e1, f1, and h1 spiculate; Australia, Cominican Republic..... ***R. lukoschusi*** **(Smiley, 1992)**

Coleoscirinae Den Heyer, 1978

Historical review. Berlese (1888) described the first Coleoscirinae, *Scirus curtipalpus*, from Argentina. Berlese (1916) then erected *Coleoscirus* for two new species, *C. halacaroides* and *C. corniculatus* (*C. corniculatus* was later synonomised with *C. curtipalpus* by Den Heyer 1978b). Smiley (1975) erected *Pseudocunaxa* and *Pseudobonzia*. *Scutascirus* was erected by Den Heyer (1976) for a South African species, *S. polyscutosus*. Den Heyer (1977a) erected *Neoscirula* for three South African cunaxids. Den Heyer (1978b) synonymized *Pseudocunaxa* with *Coleoscirus* and erected Coleoscirinae for the known genera. Tseng (1980) erected *Lapicunaxa* for two species from Taiwan. Smiley (1992) moved *Neoscirula* from Coleoscirinae to Bonziinae, synomised *Lapicunaxa* with *Coleoscirus*, and erected *Neobonzia* in Neobonzinae. Den Heyer and Castro (2008b) erected *Coleobonzia* for some species previously contained in *Pseudobonzia*. Den Heyer and Castro (2008c) moved *Neoscirula* back to Coleoscirinae. Den Heyer (2011c) moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae, and synonymized *Coleobonzia* with *Neobonzia*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemora and telofemora fused but retain a dark line. Tibiotarsi usually complemented with a tubercle and a dorsodistal solenidion. Pedipalps end in a stout claw. **Chelicera** with seta present or absent. **Subcapitulum** bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (hg_{1-4}). Setae hg_4 often longest.

Idiosoma, dorsal. Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma median plate present or absent; if present this plate separate or fused to the proterosomal shield. Plates and shields smooth or variously covered with papillae that form reticulations. Up to 8 pairs of setae present on the dorsal hysterosoma (c_1–f_1, c_2, f_2, h_2); if these setae do not occur on larger plates or shields they may be born on small platelets that are barely larger than the setal socket. Cupule *im* present, usually laterad or in the proximity of e_1. Unsclerotized integument striated.

Idiosoma, ventral. **Coxae** I–II fused and may coalesce medially to form a single sternal plate. Each pair of coxae complemented with 3 pairs of setae; if they form an extensive sternal shield, setae normally born on the unsclerotized integument may be located on the shield. Coxae III–IV fused; they may be restricted to the trochantral bases or extend posteriorly beyond the genital plates. Each pair of coxae complemented with 3 pairs of setae; if the plates are extensive they may bear setae normally born on the unsclerotized integument. The genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 1–8 pairs of setae present on the integument between coxae III and the genital plates. Anal plates complemented with 2 pairs of setae (ps_{1-2}). Two pairs of setae (h_2, *pa*) located on the integument near the anal plates. Cupule *ih* present in close proximity to h_2. **Legs** shorter than idiosoma; they are never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.

Key to adult female Coleoscirinae (modified from Den Heyer and Castro 2008b)

1 Idiosomal plates well-developed and defined; hysterosomal shield present and fused to proterosomal plate (Fig. 66a, b); females and most males with coxae I–II fused medially into a sternal shield (Fig. 67a); apices of some solenidia, especially on tarsi I, swollen **2**

– Idiosomal plates poorly developed and sometimes ill-defined; hysterosomal plate absent (Fig. 66c, d); coxae I–II usually not fused medially and restricted to trochantral bases (Fig. 67b, c); solenidia on tarsi I and II usually cylindrical..... **3**

2 (1) Idiosoma with 15 to 19 plates, including 4 pairs of dorsolateral plates (Fig. 66a); 2 dorsal plates; pedipalp tibiotarsal ventral tubercle often bifurcate (Fig. 68a) ..... ***Scutascirus***

– Idiosomal with no more than 8 plates; dorsolateral plates absent (Fig. 66b); females with only one dorsal plate but males with up to 3 dorsal plates; pedipalp tibiotarsal ventral tubercle not bifurcate, plain (Fig. 68b) ..... ***Coleoscirus* Berlese, 1916**

3 (1) Pedipalp tibiotarsus short and nearly cone-like (Fig. 69a); cheliceral trochanters broad; ambulacral claws smooth ..... ***Neoscirula* Den Heyer, 1977**

– Pedipalp tibiotarsus long and usually narrow and S-shaped (Fig. 69b); cheliceral trochanters narrow; ambulacral claws rippled **4**

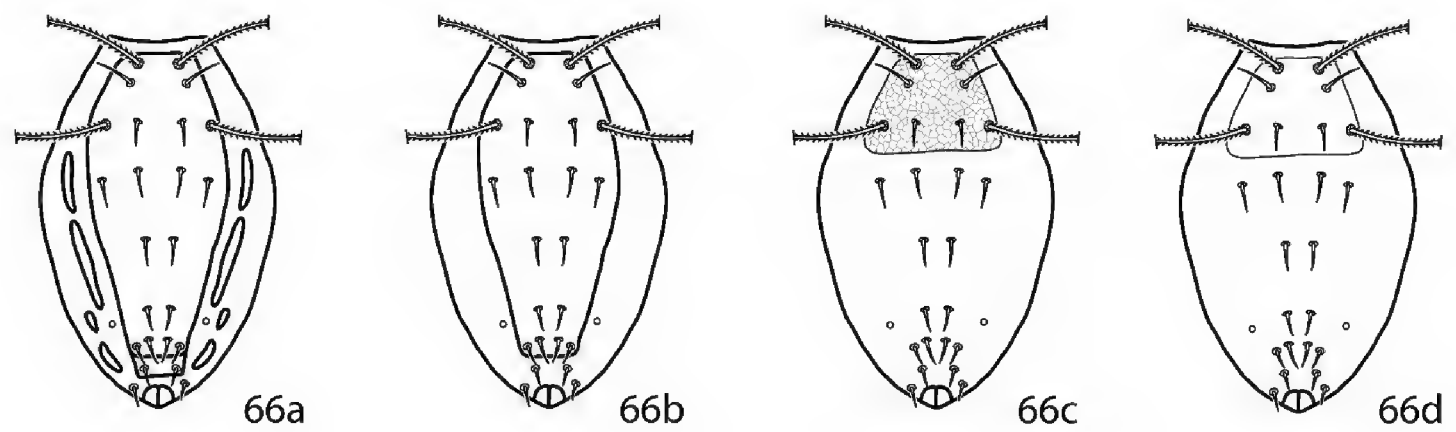
4 (3) Subcuticular reticulated pattern present on proterosomal, coxal, and genital plates: usually very conspicuous, even proximal leg segments may possess such pattern (Fig. 67c)..... **Pseudobonzia Smiley, 1975**

– Subcuticular reticulated pattern absent or restricted to the edge of coxae (Fig. 67d)..... ***Neobonzia* Smiley, 1992**

Coleoscirus Berlese, 1916

Historical review. Berlese (1916) erected *Coleoscirus* to accommodate two species, the type-species *C. halacaroides* and *C. corniculatus*. He had previously described two other species that would be assigned to the genus, *Scirus curtipalpus* (Berlese, 1888) and *Scirus brevicornis* (Berlese, 1905), but failed to recognize they belonged to *Coleoscirus*. Ewing (1917) described *Scirus simplex* from refuse hog hair in Illinois, USA. Thor and Willmann (1941) transferred *S. curtipalpus*, *S. brevicornis*, and *S. simplex* to *Cunaxa* and provided redescriptions and illustrations. Baker and Hoffmann (1948) described *Cunaxa mexicana*, as well as redescribing and illustrating *Cunaxa simplex*, *Coleoscirus curtipalpus*, and *Coleoscirus brevicornis*. Zaher et al. (1975b) reported *C. simplex* from Egypt. Smiley (1975) provided an English translation of Berlese's (1916) description of *Coleoscirus* but failed to include the genus in his key to genera; he also erected *Pseudocunaxa* for *Cunaxa simplex* and closely related species. Den Heyer (1978a) erected Coleoscirinae, designating *Coleoscirus* as the type genus and described *Coleoscirus magdalenae* and *C. tuberculatus*; he also synonymized *Pseudocunaxa* with *Coleoscirus* and

Coleoscirus corniculatus with *C. curtipalpus*. Shiba (1978) described *Cunaxa mizunoi*. Tseng (1980) erected *Lapicunaxa horidula* and *L. monospinosus*. Chaudhri (1980) described *Pseudocunaxa baptus*. Den Heyer (1980b) described *Coleoscirus coatesi*, *C. breslauensis*, and *C. buartsus*, and synonymized *C. magdalenae* with *C. simplex*. Den Heyer (1980c) erected the tribes Coleoscirini for *Coleoscirus* and *Scutascirus* and Neoscirulini for *Neoscirula* and *Pseudobonzia*. Smiley (1992) synonymized *Lapicunaxa* with *Coleoscirus* and transferred *Cunaxa mizunoi* and *Pseudocunaxa baptus* to *Coleoscirus*; he also synonymized *Cunaxa mexicanus* with *Coleoscirus curtipalpus* and provided a key to



Figures 66–69. Cunaxoidinae key illustrations. **66a–d** Idiosoma, dorsal. Position of setae will vary between species. **67a–d** Idiosoma, ventral **66a, 67a** Generalized *Scutascirus*. Presence, position, and extent of lateral plates will vary between species **66b, 67b** Generalized *Coleoscirus* **66c, 67c** Generalized *Pseudobonzia* **66d, 67d** Generalized *Neobonzia* **68a** *Scutascirus* pedipalp tibiotarsus, arrow indicates bifurcate tubercle **68b** *Coleoscirus* pedipalp tibiotarsus, arrow indicates plan tubercle **69a** *Neoscirula* pedipalps with short, cone-like tibiotarsus **69b** *Pseudobonzia* and *Neobonzia* pedipalps with elongate, s-shaped tibiotarsus.

known world species. *Coleoscirus carnus* and *C. disparis* were described by Muhammad and Chaudhri (1992a). Inayatullah and Shahid (1993) described *Pseudocunaxa carex*, *P. mardi*, and *P. kifayati*, apparently unaware or ignoring that Den Heyer (1980) had synonymized *Pseudocunaxa* with *Coleoscirus* thirteen years earlier. Bu and Li (1987c) reported *C. buartsus* from China. Corpuz-Raros (1996d) described six species of *Coleoscirus*: *C. intermedius*, *C. barrioni*, *C. dayamilocus*, *C. bakeri*, *C. leytensis*, and *C. philippinensis*. Hu (1997) reported *C. monospinosus*, *C. horidula*, and *C. buartsus* from China. Bashir, Afzal, and Khan (2006) reaffirmed Den Heyer's (1980) synonymization of *Pseudocunaxa* and *Coleoscirus* by treating *P. carex*, *P. mardi* and *P. kifayati* as *Coleoscirus* and described *C. trudus*; they also mention a second paper by Muhammad and Chaudhri (1992b) that described two additional species of *Coleoscirus* from Pakistan that I have been unable to obtain. Lin et al. (2003) reported *C. simplex* from China. Fawzy (2007) described *C. zaherii*. Bashir, Afzal, and Khan (2008) described *C. raviensis* and *C. tobaensis*. Bashir and Afzal (2009) described *C. afzali*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented; basifemora and telofemora fused but retain a dark line which indicates the presence of the joint. Pedipalps extend beyond the subcapitulum by at most the apical half of the tibiotarsi. Pedipalp tibiotarsal tubercle plain, not bifurcate as in *Scutascirus*. **Subcapitulum** bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (hg_{1-4}).

Idiosoma, dorsal. Dorsal idiosoma heavily sclerotized and the plates well-demarcated. A single dorsal shield present; it may range in size from terminating anteriorly to cupule *im* to being holodorsal. No papillated line or other marking indicates the separation of the proterosomal and hysterosomal shields. 2 pairs of setae and 2 pairs of setose sensillae present on the proterosomal. Setae c_1–h_1, c_2, and f_2 and cupule *im* present dorsally. Dorsolateral plates (such as present in *Scutascirus*) absent.

Idiosoma, ventral. **Coxae** I–II fused and coalesce medially to form a sternal shield which often has a prominent apex caudally. Sternal plate complemented with 5–7 pairs of setae. Coxae III–IV fused and may extend laterally and caudally past the genital plates. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. Anal plates bear two pairs of setae (ps_1 and ps_2). Seta h_2 located ventrally near the anal plates. Cupule *ih* present in close proximity to h_2. **Legs** shorter than the idiosoma, never constricted apically so as to end in lobes. The apices of solenidia, especially on tarsi I, may be swollen. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.

Males similar, except up to three shields or plates may occur on the dorsal idiosoma (that is the proterosomal shield may not be fused to a hysterosomal plate and up to two hysterosomal plates may be present) and coxae I–IV may be fused into a holoventral shield.

Key to adult female *Coleoscirus*

Coleoscirus brevicornis (Berlese) has been excluded from the key as the original publication (Berlese 1904) and subsequent publication detailing the species (Thor and Willmann 1941) are in Italian and German and the accompanying illustrations provide

too little detail. Den Heyer (1978b) is the last author to mention the species, but only indicates that it belongs to the genus *Coleoscirus*.

Coleoscirus carex, *C. kifayati*, and *C. mardi* have been excluded from the key as the authors did not provide enough information in the original descriptions to include them.

Coleoscirus zaherii is not included in the key as, despite the best efforts of the authors and the University of Arkansas Interlibrary Loan Department, the description could not be obtained.

1	Basifemora I with 4 setae	**2**
–	Basifemora I with 5 setae	**4**
2 (1)	Basifemora II-IV setal formula 5-4-2	**3**
–	Basifemora II-IV setal formula 6-4-2; Pakistan	***C. trudus*** **Bashir, Afzal & Khan, 2006**
–	Basifemora II-IV setal formula 6-5-2; Pakistan	***C. afzali*** **Bashir & Afzal, 2009**
3 (2)	Telofemora I-IV setal formula 4-4-4-3; Pakistan	***C. baptus*** **(Chaudhri, 1980)**
–	Telofemora I-IV setal formula 4-5-4-3; Pakistan	***C. raviensis*** **Bashir, Afzal & Khan, 2008**
4 (1)	Basifemora II with 5 setae	**5**
–	Basifemora II with 6 setae	**12**
5 (4)	Basifemora III with 4 setae	**6**
–	Basifemora III with 5 setae	**8**
6 (5)	Basifemora IV with 2 setae	7
–	Basifemora IV with 3 setae; Java, South Africa	***C. halacaroides*** **Berlese, 1916**
7 (6)	Horizontal reticulations on dorsal shield present (Fig. 70); Taiwan	***C. horidula*** **(Tseng, 1980)**
–	Horizontal reticulations on dorsal shield absent; Taiwan	***C. monospinosus*** **(Tseng, 1980)**
8 (5)	Basifemora I-IV setal formula 4-5-3-3; Argentina	***C. curtipalpus*** **(Berlese, 1888)**
–	Basifemora I-IV setal formula not as above	**9**
9 (8)	Sternal shield bilobed posteriorly; Philippines	***C. barrioni*** **Corpuz-Raros, 1996**
–	Sternal shield not bilobed posteriorly	**10**
10 (9)	Extensive reticulations on gnathosoma present (Fig. 71); Philippines	***C. bakeri*** **Corpuz-Raros, 1996**
–	Extensive reticulations on gnathosoma absent	**11**
11 (10)	Hysterosomal shield present, complemented with c_1-f_1, c_2, f_2; Philippines	***C. philippinensis*** **Corpuz-Raros, 1996**
–	Hysterosomal shield absent; Philippines	***C. intermedius*** **Corpuz-Raros, 1996**
12 (4)	Basifemora III with 4 setae	**13**
–	Basifemora III with 5 setae	**17**
–	Basifemora III with 6 setae	**20**

13 (12) Telofemora I-IV setal formula 4-4-4-3; USA, South Africa, Japan ..... ***C. simplex*** **(Ewing, 1917)**

– Telofemora I-IV setal formula 5-5-4-3 ..... **14**

14 (13) Setae f_1, f_2 born on soft integument **15**

– Setae f_1, f_2 born on dorsal shield; Pakistan ..... ***C. tobaensis*** **Bashir, Afzal & Khan, 2008**

15 (14) Sternal plate rounded posteriomedially (Figs 72a, b); South Africa ..... ***C. tuberculatus*** **Den Heyer, 1978**

– Sternal plate truncated posteriomedially (Fig. 72c) **16**

16(15) Light reticulation on dorsal shield present; dorsal shield evenly sclerotized (Fig. 73a); South Africa ..... ***C. buartsus*** **Den Heyer, 1980**

– Light reticulation on dorsal shield absent; dorsal shield unevenly sclerotized (Fig. 73b); South Africa ..... ***C. coatesi*** **Den Heyer, 1980**

17(12) Sternal shield indented posteriomedially (Fig. 72a); Malaysia ..... ***C. mizunoi*** **(Shiba, 1978)**

– Sternal shield not indented posteriomedially (Fig. 72b) **18**

18 (17) Setae f_2 born on soft integument; Pakistan ..... ***C. disparis*** **Muhammad & Chaudhri, 1992**

– Setae f_2 born on dorsal shield **19**

19 (18) Integumental dots on legs I-IV forming rows (Fig. 74a); Pakistan ..... ***C. carnus*** **Muhammad & Chaudhri, 1992**

– Integumental dots on legs I-IV forming random (Fig. 74b); South Africa..... ***C. breslauensis*** **Den Heyer, 1980**

20 (12) Basifemora IV with 2 setae; Philippines ..... ***C. leytensis*** **Corpuz-Raros, 1996**

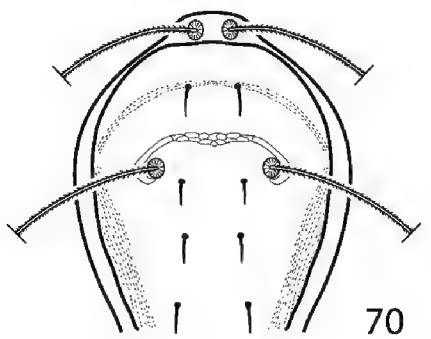
– Basifemora IV with 3 setae; Philippines ..... ***C. dayamilocus*** **Corpuz-Raros, 1996**

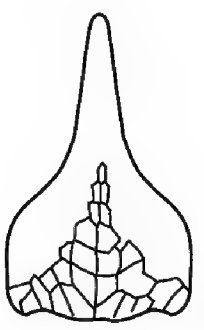
Neobonzia Smiley, 1992

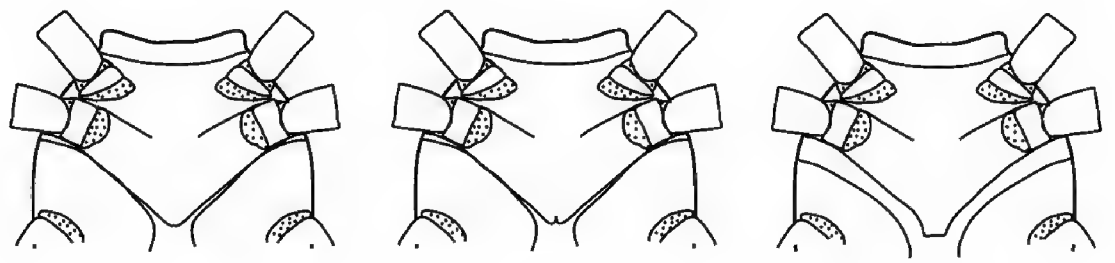
Historical review. Berlese (1910) described the first species of *Neobonzia*, *Scirus parvirostris*. Thor and Willmann (1941) moved *S. parvirostris* to *Cunaxa*. Baker and Hoffmann (1948) described *Cunaxa snowi*. Heryford (1965) described *Cunaxa reticulata*. Smiley (1975) erected the genus *Pseudobonzia*, with *C. reticulata* as the type species. Den Heyer (1977c) redescribed *Pseudobonzia*, moved *C. parvirostris* to *Pseudobonzia*, and described six new species from South Africa: *P. argillae*, *P. nona*, *P. lootsi*, *P. themedae*, and *P. saaymani*. *Pseudobonzia parilis* was described by Chaudhri (1977). Den Heyer (1980b) described *P. smileyi* and transferred *C. snowi* to *Pseudobonzia*. Chaudhri (1980) described *P. numida*. Luxton (1982) described *P. breviscuta* from New Zealand peat moss. Liang (1983) reported *P. themedae* from China. *Pseudobonzia shanghaiensis* was described by Liang (1984). Smiley (1992) described *P. newzealandicus*, *P. landwehri*, and *P. summersi*; reported *P. saaymani* from the USA and Canada;

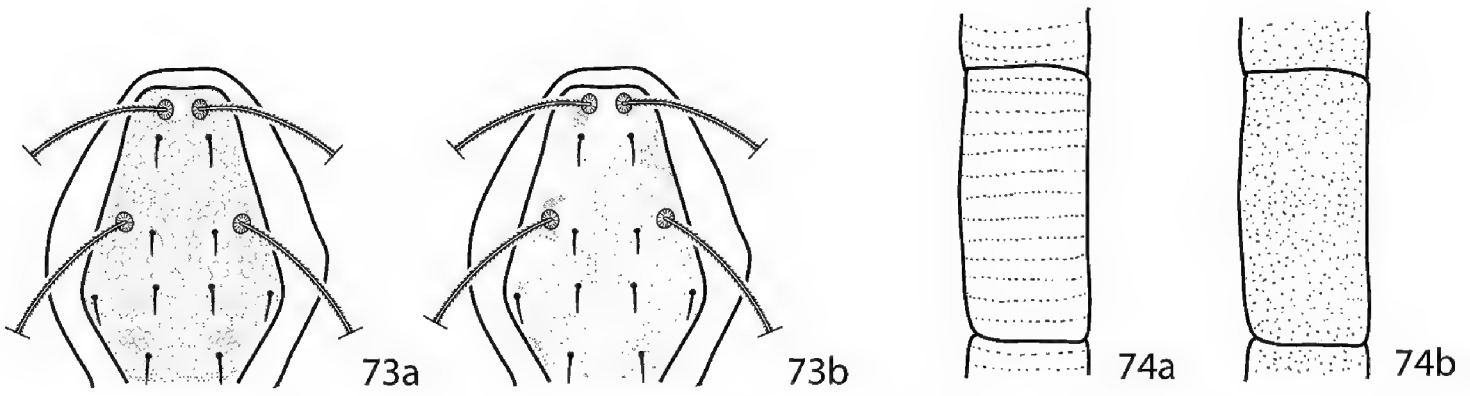
and erected a new monotypic subfamily, Neobonzinae, and genus, *Neobonzia*, for *N. moseri*. Corpuz-Raros and Garcia (1996) described two species from the Philippines, *P. gruezoi* and *P. longispina*. Hu (1997) reported *P. shanghaiensis* and *P. themedae* from China. Sergeyenko (2005) described *P. kuznetzovi*. *P. clavata* was described by Corpuz-Raros (2008). Den Heyer and Castro (2008b) split a new genus, *Coleobonzia*, from *Pseudobonzia*; They retained 6 speciesin *Pseudobonzia* (*P. clathratus*, *P. delfinadobakerae*, *P. landwehri*, *P. neoreticulata*, *P. reticulata*, and *P. yini*) and transferred all other species to *Coleobonzia* and described *C. clava* and *C. moraesi*. Bashir and Afzal (2009) described *P. bakari*, *P. malookensis*, and *P. shamshadi*. Den Heyer (2011) synonymized *Coleobonzia* with *Neobonzia* and moved *Neobonzia* to Coleoscirinae, effectively disregarding Neobonzinae.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the last segment. Simple setae present on the basi- and









Figures 70–74. *Coleoscirus* key illustrations. **70** Dorsal idiosomal shield with horizontal reticulations present **71** Gnathosoma with extensive reticulations present **72a** Sternal plate rounded posteriomedially, indentation absent **72b** Sternal plate rounded posteriomedially, indentation present **72c** Sternal plate truncated posteriomedially **73a** Dorsal idiosomal shield even sclerotized, light reticulation present **73b** Dorsal idiosomal shield unevenly sclerotized, light reticulation absent **74a** Integumental dots on legs forming rows **74b** Integumental dots on legs random.

telofemora. Pedipalp tibiotarsi long and S-shaped (as opposed to short and cylindrical as in *Neoscirula*). **Subcapitulum** with 4 pairs of setae (hg_{1-4}). 2 pairs of adoral setae present. **Chelicera** with seta usually present. Extensive reticulated pattern absent from the gnathosoma, though a row of single cells may be present caudally.

Idiosoma, dorsal. Plates lightly sclerotized and may not be well defined or demarcated. Proterosomal plate bears 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Extensive reticulated pattern absent, although a pair of rows of up to 6 cells may be present. Proterosomal plate may be covered with random dots or papillae. Hysterosomal plate absent. Setae c_1–h_1, and usually c_2 and f_2 present dorsally; h_2 present or absent. Cupules *im* present laterad and sometimes caudally of e_1. Integument striated.

Idiosoma, ventral. **Coxae** usually restricted to the trochantral bases, though sometimes coxae I–II may nearly touch medially. Coxae I–II fused. Coxae III–IV fused. All coxae lightly sclerotized and may be ill-defined. Extensive reticulated pattern absent from the coxae, though a row of cells or reticulated pattern may be present near the edges. Coxae may be covered with random dots or papillae. Coxae I–IV usually have the simple setal formula 3-3-3-3 (*N. parilis* is the exception with 2-2-3-2). Genital plates each bear 3–4 setae; 2 pairs of genital papillae visible underneath the plates. 2 pairs of setae (ps_{1-2}) usually occur on the anal plates and 1 pair of setae (*pa*) occurs on the integument near the anal plates. However, at least one species (*N. clavata*) has 3 pairs of setae present on the anal plates and 0 pairs of setae on the integument. Cupules *ih* present ventrally near the anal plates. **Legs.** Tarsi never constricted apically so as to end in lobes. The apices of solenidia cylindrical, not swollen as in *Coleoscirus* and *Scutascirus*. Trichobothrium on leg tibia IV present. Ambulacral claws rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Neobonzia*

As suggested by Den Heyer (2013) *Pseudobonzia bakari*, *P. malookensis*, and *P. shamshadi* are transferred to *Neobonzia*.

Neobonzia parvirostris (Berlese, 1910) is known only from the male and so is not included in the key. *N. breviscuta* (Luxton, 1982) is not included in the key as an insufficient number of characters are given in the original description.

1	Sensilla *at* and *pt* clavate (Figs 75a, b)	**2**
–	Sensilla *at* and *pt* not clavate, normal (Fig. 75c)	**3**
2 (1)	Sensilla *at* and *pt* short, length less than width of proterosomal plate (Fig. 75a); Philippines	***N. clavata* (Corpuz-Raros, 2008)**
–	Sensilla *at* and *pt* long, length greater than width of proterosomal plate (Fig. 75b); Brazil	***N. clava* (Den Heyer & Castro, 2008)**
3 (1)	Coxae I–IV setal formula 2-2-3-2 sts; Pakistan	***N. parilis* (Chaudhri, 1977)**
–	Coxae I–IV setal formula 3-3-3-3 sts	**4**
4 (3)	Basifemora I with 2 sts	**5**

–	Basifemora I with 3 sts; Philippines ..... ***N. longispina*** **(Corpuz-Raros & Garcia, 1996)**
–	Basifemora I with 4 sts **7**
–	Basifemora I with 5 sts **12**
5 (4)	Basifemora II–IV setal formula 2-2-1 sts; USA ..... ***N. moseri*** **Smiley, 1992**
–	Basifemora II–IV setal formula 2-1-0 sts; Pakistan ..... ***N. malookensis*** **(Bashir & Afzal, 2009)**
–	Basifemora II–IV setal formula 3-3-1 sts **6**
–	Basifemora II–IV setal formula 4-4-1 sts ..... ***N. bakari*** **(Bashir & Afzal, 2009)**
6 (5)	Telofemora I–IV setal formula 4-6-4-2 sts; China ..... ***N. themedae*** **(Den Heyer, 1977)**
–	Telofemora I–IV setal formula 5-5-4-3 sts; South Africa ..... ***N. lootsi*** **(Den Heyer, 1977)**
7 (4)	Basifemora II with 4 sts **8**
–	Basifemora II with 5 sts ..... ***P. shamshadi*** **(Bashir & Afzal, 2009)**
–	Basifemora II with 6 sts **10**
8 (7)	Basifemora III–IV setal formula 4-2 sts **9**
–	Basifemora III–IV setal formula 6-1 sts; New Zealand ..... ***N. newzealandicus*** **(Smiley, 1992)**
9 (8)	Pedipalp tibiotarsal tubercle present; Brazil ..... ***N. moraesi*** **(Den Heyer & Castro, 2008)**
–	Pedipalp tibiotarsal tubercle absent; South Africa ..... ***N. saaymani*** **(Den Heyer, 1977)**
10 (7)	Basifemora III–IV setal formula 3-0 sts; South Africa ..... ***N. nona*** **(Den Heyer, 1977)**
–	Basifemora III–IV setal formula 3-1 sts; South Africa ..... ***N. argillae*** **(Den Heyer, 1977)**
–	Basifemora III–IV setal formula 4-2 sts **11**
11 (10)	Setae *lps* and *mps* subequal; South Africa ..... ***N. smileyi*** **(Den Heyer, 1980)**
–	Setae *lps* about half as long as *mps*; USA ..... ***N. summersi*** **(Smiley, 1992)**
12 (4)	Basifemora II with 5 sts **13**
–	Basifemora II with 6 sts **14**
13 (12)	Coxae I–II nearly touching medially (Fig. 76a); USA, Austria ..... ***N. snowi*** **(Baker & Hoffmann, 1948)**
–	Coxae I–II widely separated medially (Fig. 76b); Philippines ..... ***N. gruezoi*** **(Corpuz-Raros & Garcia, 1996)**
14 (12)	Basifemora III–IV with 5-2 sts **15**
–	Basifemora III–IV with 6-2 sts; Pakistan ..... ***N. numida*** **(Chaudhri, 1980)**
15 (14)	Setae g_4 longest; posterior corners of proterosomal shield angled; China ..... ***N. shanghaiensis*** **(Liang, 1980)**
–	Setae g_3 longest; posterior corners of proterosomal shield rounded; Russia .... ***N. kuznetzovi*** **(Sergeyenko, 2005)**

Neoscirula Den Heyer, 1977

Historical review. Den Heyer (1977a) erected *Neoscirula* for three African cunaxids, *N. theroni*, *N. natalensis*, and *N. sevidi*. Shiba (1978) described the first *Neoscirula* outside of Africa, *Coleoscirus ogawai*. Den Heyer (1978b) erected the subfamily Coleoscirinae , tribus Neoscirulini and assigned *Neoscirula* to it. Den Heyer (1980b) described another African *Neoscirula*, *N. delareyi*. *N. vitulus* was described from Ukraine by Barilo (1991). Smiley (1992) transferred *Neoscirula* from Coleoscirinae to Bonziinae as he thought setae g_1 were geniculate; he also described *N. luxtoni*, *N. proctorae*, *N. kenworthyi*, moved *N. ogawai* from *Coleoscirus*, and provided a key to known world species. *N. abraensis*, *N. aspirasi*, *N. imperata*, *N. makilingica*, *N. puntiglupa* were described by Corpuz-Raros (1996e) from the Philippines. Lin and Zhang (1998) described *N. miaofengensis* and *N. bidens*. *N. saitoi* was described by Lin and Zhang (2002). Corpuz-Raros (2007) described two more Philippine *Neoscirula*: *N. laboensis*, *N. taclobanensis*. Mejía-Recamier and Palacios-Vargas (2007) described *N. aliciae*, *N. baloghi*, and *N. hoffmannae*. Den Heyer and Castro (2008c) described *N. flechtmanni*, *N. oliveirai*, and *N. queirozi*. Skvarla, Fisher, and Dowling (2011) described *N. reticulata*. Den Heyer (2011c) described *N. sepasgosariani*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and end in a strong claw, which is complemented with a tooth in some species; they extend to the tip of the hypognathum or slightly beyond. Basifemur and telofemur are fused but retain the suture; each has a dorsolateral simple or spine-like seta. Pedipalp tibiotarsus short and cone-like. **Subcapitulum** with 4 pairs of setae (hg_{1-4}). Seta hg_1 longest and in some species bent at 90 degrees, though not geniculate as in Bonziinae. Adoral setae present or absent. **Chelicera** with seta present or absent.

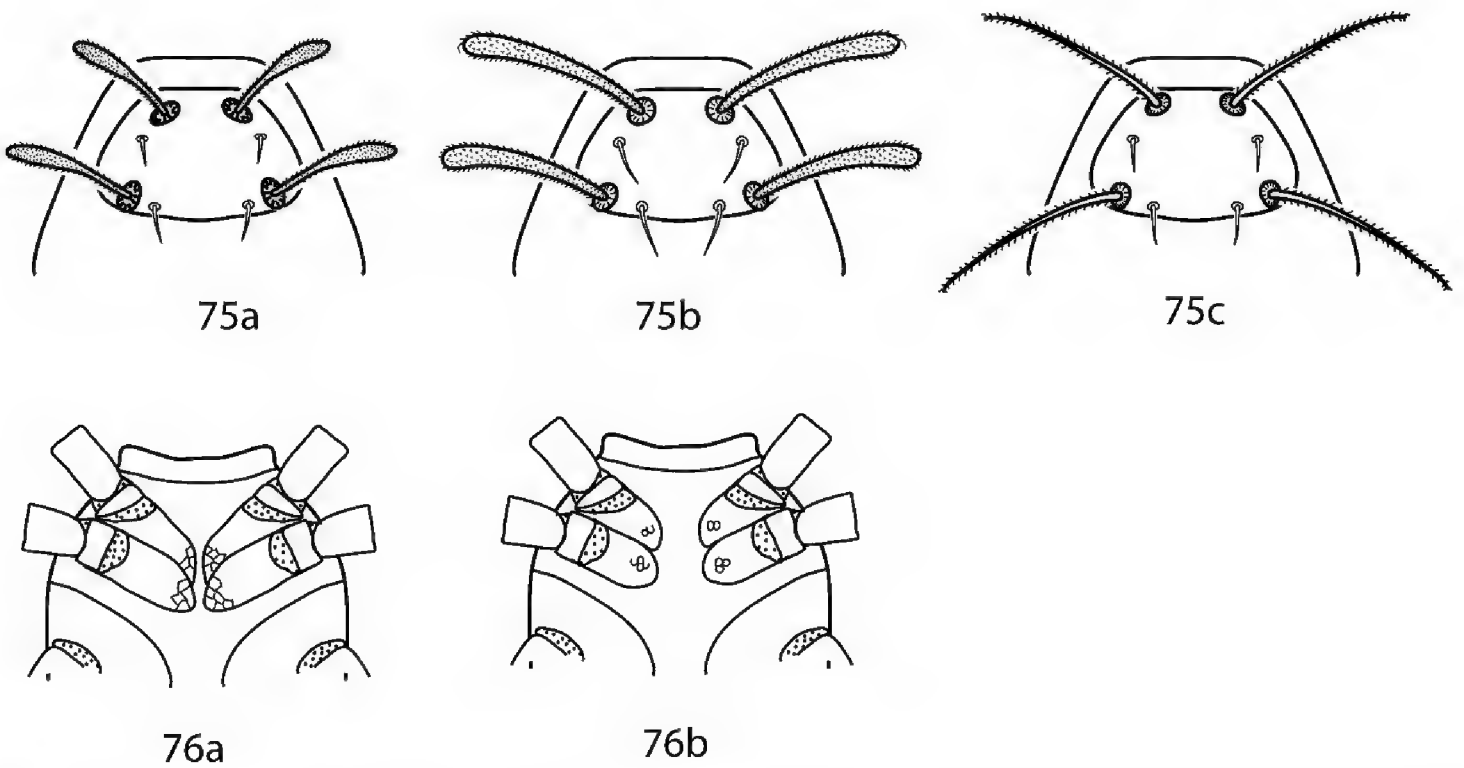
Idiosoma, *dorsal*. Proterosomal shield weakly sclerotized and ill-defined, granulated or papillated; some species possess subcuticular reticulations.

Idiosoma, ventral. **Coxae** I–II separate or fused medially into a single sternal shield. Coxae III–IV contiguous on either side, restricted to area around trochantral bases. Dorsal cupules *im* present laterad to e_1; ventral cupules *ih* present near h_2, anal plates. **Legs** shorter than body. Tarsi never constricted apically so as to end in lobes. Apices of solenidia cylindrical, not swollen as in *Coleoscirus* and *Scutascirus*. Trichobothrium on leg tibia IV present. Ambulacral claws smooth and occur on either side of a 4-rayed empodium.

Key to adult female *Neoscirula*.

Neoscirula hoffmannae Mejía-Recamier & Palacios-Vargas, 2007 is excluded from the following key as it is only known from the male.

1	Coxae I–II fused to form a sternal shield	**2**
–	Coxae I–II separated	**6**
2 (1)	Cheliceral seta present	**3**
–	Cheliceral seta absent	**5**



Figures 75, 76. *Neobonzia* key illustrations **75a** Sensilla *at* and *pt* clavate, short, length less than the width of the proterosomal shield **75b** Sensilla *at* and *pt* clavate, long, length greater than the width of the proterosomal shield **75c** Sensilla *at* and *pt* normal, not clavate **76a** Coxae I–II nearly touching medially **76b** Coxae I–II widely separated medially.

3 (2) Pedipalp basifemoral dorsal seta spine-like (Fig. 77a); Luzon Is., Philippines.. .....***N. makilingica*** **Corpuz-Raros, 1996**

– Pedipalp basifemoral dorsal seta simple (Fig. 77b) **4**

4 (3) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 78a); posteromedial portion of sternal shield V-shaped, polygonal subcuticular sculpturing absent (Fig. 79a); 6 pairs of setae between coxae III–IV (excluding genital setae); Luzon Is., Philippines.....***N. aspirasi*** **Corpuz-Raros, 1996**

– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig.78b); posteromedial portion of sternal shield rounded, polygonal subcuticular sculpturing present (Fig. 79b); 4 pairs of setae between coxae III–IV (excluding genital setae); Malaysia; Philippines .....***N. ogawai*** **(Shiba, 1978)**

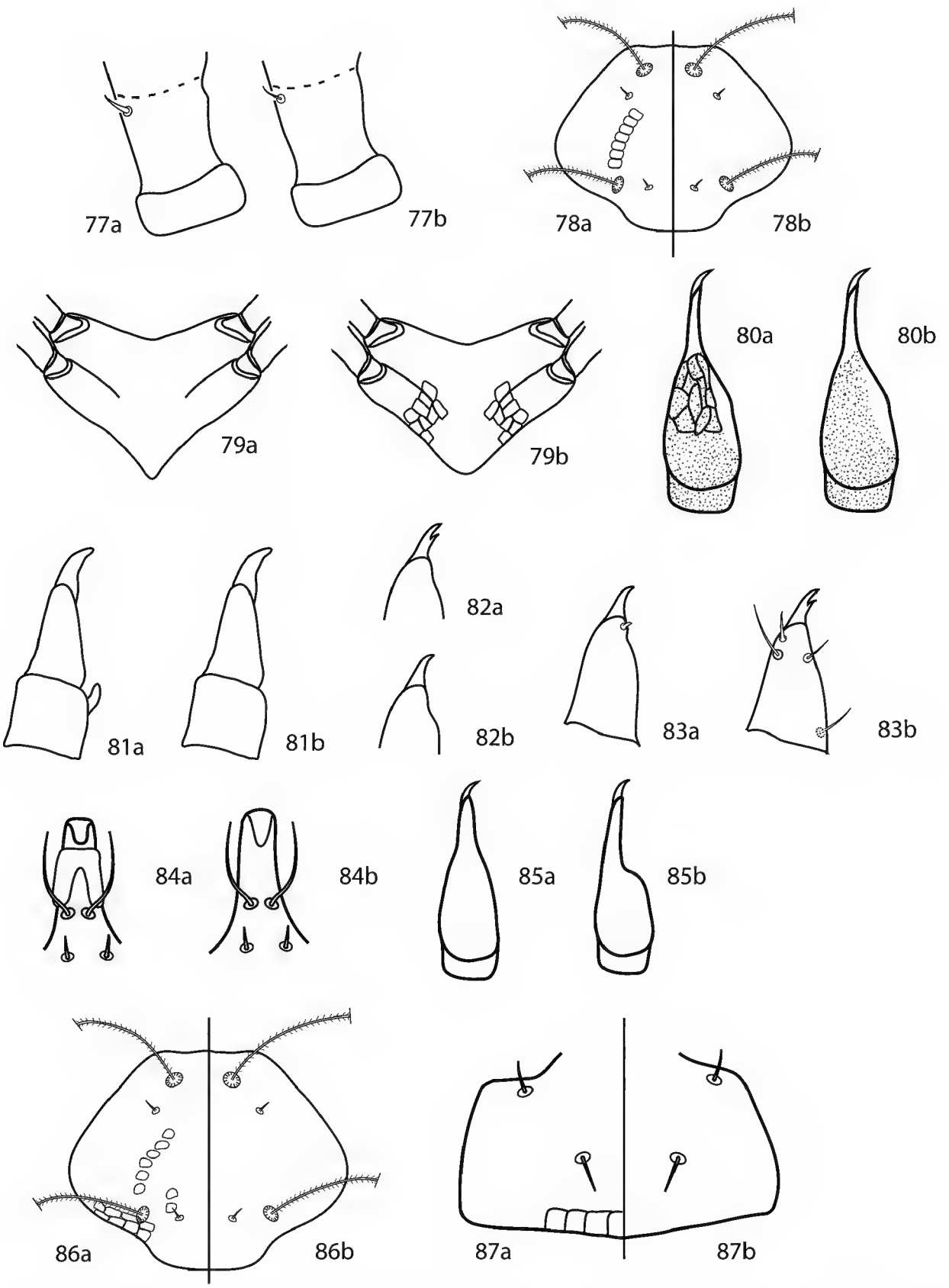
5 (2) .....Chelicerae with dorsomedial reticulations present (Fig. 80a); genua II with 5 setae and 2 solenidia; genua IV with 5 setae and 1 solenidion; Interior Highlands, USA .....***N. reticulata*** **Skvarla, 2011**

– Chelicerae dorsomedial reticulations absent (Fig. 80b); genua II with 4 setae and 2 solenidia; genua IV with 4 setae and 1 solenidion; Jalisco, Mexico..... .....***N. baloghi*** **Mejía-Recamier & Palacios-Vargas, 2007**

6 (1) Pedipalp genua hook-like apophysis present (Fig. 81a); South Africa..... .....***N. natalensis*** **Den Heyer, 1977**

– Pedipalp genua hook-like apophysis absent (Fig. 81b) **7**

7 (6) Pedipalp tibiotarsal claw a tooth present, giving bifid appearance (Fig. 82a).. **8**



Figures 77–87. *Neoscirula* key illustrations **77a** Pedipalp basifemoral dorsal seta spine-like **77b** Pedipalp basifemoral dorsal seta simple **78a** Proterosomal shield with polygonal subcuticular sculpturing present **78b** Proterosomal shield with polygonal subcuticular sculpturing absent **79a** Sternal shield v-shaped posteriomedially, with polygonal subcuticular sculpturing absent **79b** Sternal shield rounded posteriomedially, with polygonal subcuticular sculpturing present **80a** Chelicera with dorsomedial reticulations present **80b** Chelicera with dorsomedial reticulations absent **81a** Pedipalp genua with hook-like apophysis present **81b** Pedipalp genua with hook-like apophysis absent **82a** Pedipalp tibiotarsal claw with tooth present **82b** Pedipalp tibiotarsal claw with tooth absent **83a** Pedipalp tibiotarsus with tubercle present **83b** Pedipalp tibiotarsus with tubercle absent **84a** Hypognathum with ventroapical shield-like process present **84b** Hypognathum with ventroapical shield-like process absent **85a** Chelicera tapering gradually **85b** Chelicera tapering suddenly **86a** Proterosomal shield with polygonal subcuticular sculpturing present **86b** Proterosomal shield with polygonal subcuticular sculpturing absent **87a** Subcapitulum with row of basal subcuticular sculpturing present **87b** Subcapitulum with row of basal subcuticular sculpturing absent.

– Pedipalp tibiotarsal claw a tooth absent (Fig. 82b) **13**

8 (7) Cheliceral seta present; pedipalp tibiotarsal tubercle present (Fig. 83a) **9**

– Cheliceral seta absent; pedipalp tibiotarsal tubercle absent (Fig. 83b); São Paulo, Brazil ..... ***N. oliveirai*** **Den Heyer & Castro, 2008**

9 (8) Basifemora II with 4 setae; telofemora I–II 4-4 setae; hypognathum with ventroapical shield-like process present (Fig. 84a); New Zealand; Philippines .... ***N. luxtoni*** **Smiley, 1992**

– Basifemora II with 5 or 6 setae; telofemora I–II 5-5 setae; hypognathum with ventroapical shield-like process absent (Fig. 84b) **10**

10 (9) Basifemora II with 5 setae **11**

– Basifemora II with 6 setae **12**

11 (10) Basifemora I with 4 setae; telofemora III with 4 setae; 7 pairs of setae between coxae III–IV (excluding genital setae); Jalisco, Mexico .... ***N. aliciae*** **Mejía-Recamier & Palacios-Vargas, 2007**

– Basifemora I with 5 setae; telofemora III with 3 setae; 5 pairs of setae between coxae III–IV (excluding genital setae); Luzon Is., Philippines .... ***N. laboensis*** **Corpuz-Raros, 2007**

12 (10) Chelicerae tapering gradually (Fig. 85a); Fujian, China .... ***N. bidens*** **Lin & Zhang, 1988**

– Chelicerae tapering suddenly (Fig. 85b); São Paulo, Brazil..... ..... ***N. flechtmanni*** **Den Heyer & Castro, 2008**

13 (7) Pedipalp basifemoral dorsal seta spine-like (Fig. 77a) **14**

– Pedipalp basifemoral dorsal seta simple (Fig. 77b) **18**

14 (13) Telofemora I–II with 4-4 setae; New Zealand.... ***N. proctorae*** **Smiley, 1992**

– Telofemora I–II with 5-5 setae **15**

15 (14) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 86a); Fujian, China ..... ***N. saitoi***

– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 86b)..... **16**

16 (15) Cheliceral seta short, less than half the length of movable digit; South Africa ... . ***N. sevidi*** **Den Heyer, 1977**

– Cheliceral seta long, nearly as long or longer than movable digit..... **17**

17 (16) Basifemora I–IV setal formula 5-5-4-3; Iran..... ..... ***N. sepasgosariani*** **Den Heyer, 2011**

– Basifemora I–IV setal formula 4-4-3-1; Brazil..... ..... ***N. queirozi*** **Den Heyer & Castro, 2008**

18 (13) Coxae I–II with polygonal subcuticular sculpturing present (as in Fig. 79a).... **19**

– Coxae I–II with polygonal subcuticular sculpturing absent (as in Fig. 79b)..... **23**

19 (18) Proterosomal shield with polygonal subcuticular sculpturing present (Fig. 78a)..... **20**

– Proterosomal shield with polygonal subcuticular sculpturing absent (Fig. 78b)..... **21**

20 (19) Basifemora II with 4 setae; telofemora I–II 4-4 setae; Maryland, USA..... ..... ***N. kenworthyi*** **Smiley, 1992**

– Basifemora II with 5 setae; telofemora I–II with 5-5 setae; Leyte Is., Philippines ..... ***N. taclobanensis*** **Corpuz-Raros, 2007**

21 (19) Hypognathal setae hg_1 more than two times as long as setae $hg_{2–4}$; coxae II with 4 setae; Fujian, China ..... ***N. miaofengensis*** **Lin & Zhang, 1988**

– Hypognathal setae hg_1 no more than two times as long as setae $hg_{2–4}$; coxae II with 3 setae **22**

22 (21) Chelicerae basally narrow, less than three times the width of the distal end; hypognathum narrow, nearly twice as long as wide; Uzbekistan..... ..... ***N. vitulus*** **Barilo, 1991**

– Chelicerae basally broad, four times the width of the distal end; hypognathum wide, nearly as wide as long; South Africa..... ..... ***N. delareyi*** **Den Heyer, 1980**

23 (18) Proterosomal shield with polygonal subcuticular sculpturing present..... **24**

– Proterosomal shield with polygonal subcuticular sculpturing absent; Luzon Is., Philippines ..... ***N. imperata*** **Corpuz-Raros, 1996**

24 (23) Subcapitulum with row of basal polygonal subcuticular sculpturing present (Fig. 87a); ventrally with 7 pairs of simple setae between coxae III–IV **25**

– Subcapitulum with row of basal polygonal subcuticular sculpturing absent (Fig. 87b); ventrally with 6 pairs of simple setae between coxae III–IV; Luzon Is., Philippines ..... ***N. abraensis*** **Corpuz-Raros, 1996**

25 (24) Basifemora II with 4 setae; telofemora I–II with 4-4 setae; Western Transvaal, South Africa..... ***N. theroni*** **Den Heyer, 1977**

– Basifemora II with 5 setae; telofemora I–II with 5-5 setae; Luzon Is., Philippines ..... ***N. puntiglupa*** **Corpuz-Raros, 1996**

Pseudobonzia Smiley, 1975

Historical review. Heryford (1965) described the first *Pseudobonzia*, *Cunaxa reticulata*. Smiley (1975) erected the genus *Pseudobonzia*, with *C. reticulata* as the type species. Den Heyer (1977c) redescribed the genus and described *P. neoreticulata*. Shiba (1978) described *Cunaxoides clathratus*. Smiley (1992) described *P. delfinadobakerae*, *P. landwehri*, and *P. yini* and moved *Cunaxoides clathratus* to *Pseudobonzia;* he also provided a key to known world species. Fuangarown and Lekprayoon (2004) described *P. tangkansingae*. Den Heyer and Castro (2008b) split *Coleobonzia* from *Pseudobonzia*. Bashir, Afzal, and Akbar (2008) described *P. ashfaqi*. Skvarla et al. (2013) reported *P. reticulata* from Arkansas and corrected the description to include setae f_2, which were not reported by Heryford (1965).

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the last segment. Simple or spine-like setae on the basi- and telofemora present. Pedipalp tibiotarsi long and S-shaped (as opposed to short and cylindrical as in *Neoscirula*). **Subcapitulum** with 4 pairs of setae ($hg_{1–4}$). 2

pairs of adoral setae present. **Chelicera** with seta present (usually) or absent. Extensive reticulated pattern present on the gnathosoma.

Idiosoma, dorsal. Plates lightly sclerotized and not be well defined or demarcated. The proterosomal plate bears 2 pairs of setae (*lps* and *mps*) and 2 pairs of setose sensillae (*at* and *pt*). Extensive reticulated pattern present. Hysterosomal plate absent. Setae c_1–h_1 present; setae c_2, f_2, and h_2 present or absent. Cupules *im* present laterad and caudally of e_1. Integument striated.

Idiosoma, ventral. **Coxae** restricted to the trochantral bases. Coxae I–II fused. Coxae III–IV fused. All coxae lightly sclerotized and may be ill-defined. Coxae with extensive reticulated pattern. Coxae I–IV usually have setal formula 3-3-3-3. Genital plates each bear 3–4 setae; 2 pairs of genital papillae visible underneath the plates. 2 pairs of setae ($ps_{1–2}$) occur on the anal plates and 1 pair of setae (*pa*) occurs on the integument near the anal plates. Cupules *ih* present ventrally near the anal plates. **Legs.** Basal leg podomeres with reticulated pattern present or absent. Tarsi never constricted apically so as to end in lobes. Apices of solenidia cylindrical, not swollen as in *Coleoscirus* and *Scutascirus*. Trichobothrium on leg tibia IV present. Ambulacral claws are rippled and occur on either side of a 4-rayed empodium.

Key to adult female *Pseudobonzia* (modified from Den Heyer and Castro 2008)

1 Pedipalp basifemora and telofemora with similar setae, either spine-like or simple (Fig. 88a, b); proterosomal shield conspicuously reticulated **2**

– Pedipalp basifemora with simple seta, pedipalp telofemora with spine-like seta (Fig. 88c); proterosomal shield not conspicuously reticulated; Mexico ... ***P. delfinadobakerae*** **Smiley, 1992**

2 (1) Pedipalp basifemora and telofemora with simple setae (Fig. 88a); setae f_2 present or absent **3**

– Pedipalp basifemora and telofemora with spine-like setae (Fig. 88b); setae f_2 present; Guam ..... ***P. yini*** **Smiley, 1992**

3 (2) Setae f_2 present **4**

– Setae f_2 absent **5**

4 (3) Proterosomal shield concave posteromedially (Fig. 89a); South Africa ..... ***P. neoreticulata*** **Den Heyer, 1977**

– Proterosomal shield straight posteromedially (Fig. 89b); USA ..... ***P. landwehri*** **Smiley, 1992**

– Proterosomal shield convex posteromedially (Fig. 89c); Pakistan ..... ***P. ashfaqi*** **Bashir, Afzal & Akbar, 2008**

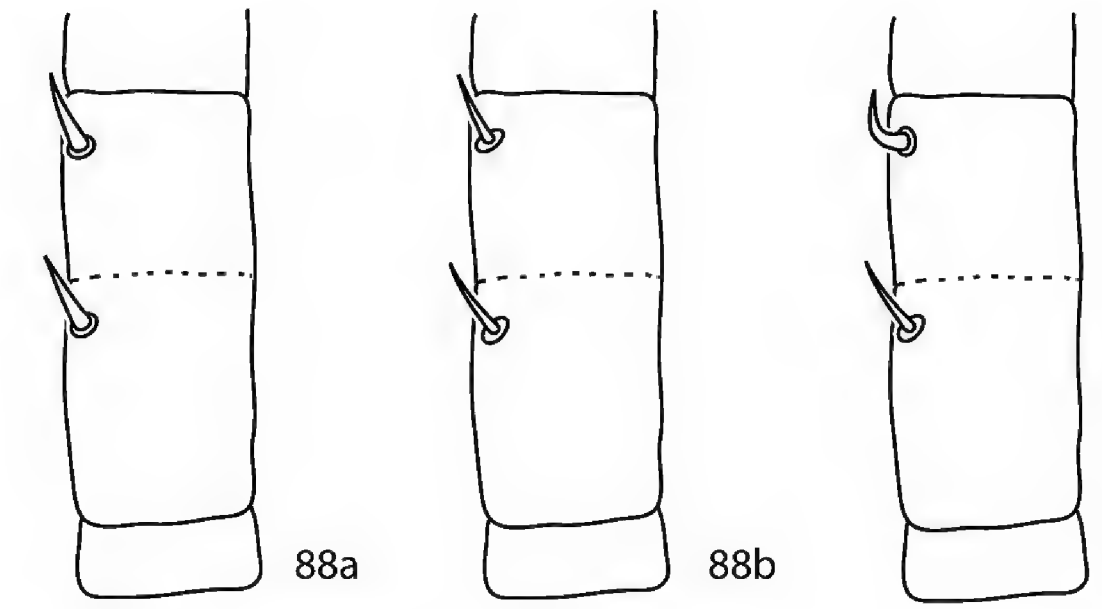
5 (3) Proximal leg podomeres reticulated; Malaysia ..... ***P. clathratus*** **(Shiba, 1978)**

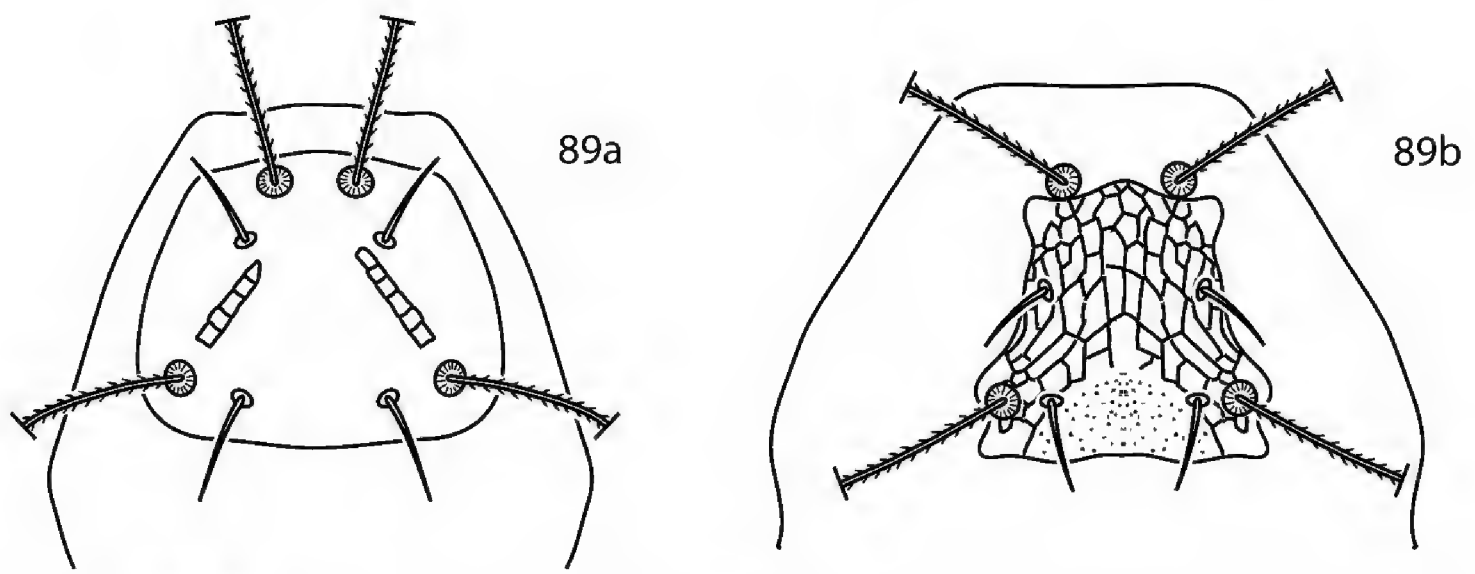
– Proximal leg podomeres not reticulated; USA ..... ***P. reticulata*** **(Heryford, 1965)**

Scutascirus Den Heyer, 1976

Historical review. Den Heyer (1976) erected *Scutascirus* for *S. polyscutosus*. Shiba (1978) described *Cunaxa exasperatus*. Den Heyer (1980b) described *S. braziliensis*. Chaudhri (1980) described *S. pigrus*. Smiley (1992) transferred *C. exasperatus* to *Scutascirus*. Corpuz-Raros and Garcia (1996) described *S. contiguus* and *S. pentascutellus*. Lin, Zhang and Ji (2001) described *S. triangulum*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemora and telofemora fused but retain a dark line. The tibiotarsi complemented with a tubercle and a dorsodistal solenidion. Pedipalps end in a stout claw. **Chelicera** with seta present or absent. **Subcapitulum** bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae ($hg_{1–4}$). Setae hg_4 often the longest.





Figures 88, 89. *Pseudobonzia* key illustrations **88a** Pedipalp basifemur and telofemur with spine-like setae on both segments **88b** Pedipalp basifemur and telofemur with simple setae on both segments **88c** Pedipalp with simple seta on basifemur, spine-like seta on telofemur **89a** Proterosomal plate convex posteriomedially **89b** Proterosomal plate not convex posteriomedially.

Idiosoma, dorsal. Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma bears a median plate which is fused with the proterosomal shield and four pairs of lateral platelets. Plates and shields covered with papillae that form reticulations. 8 pairs of setae present on the dorsal hysterosoma (c_1–f_1, c_2, f_2, h_2); these setae occur on the fused dorsal shield. Cupule *im* present, usually laterad or in the proximity of e_1. Unsclerotized integument striated.

Idiosoma, ventral. **Coxae** I–II fused and coalesce medially to form a single sternal plate. Each pair of coxae complemented with 3 pairs of setae; if they form an extensive sternal shield setae normally born on the unsclerotized integument may be located on the shield. Coxae III–IV fused and extend posteriorly beyond the genital plates. Genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 1–8 pairs of setae present on the integument between coxae III and the genital plates. Anal plates complemented with 2 pairs of setae ($ps_{1\text{-}2}$). Two pairs of setae (h_2, *pa*) located on the integument near the anal plates. Cupule *ih* present in close proximity to h_2. **Legs** shorter than idiosoma. Tarsi never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.

Key to adult female *Scutascirus*

Scutascirus tactus is not included in the following key as it is described only from the male.

1 Tubercle on inner margin of pedipalp tibiotarsus not branched (Fig. 90a)..**2**

– Tubercle on inner margin of pedipalp tibiotarsus bifurcate (Figs 90b,c).....**5**

– Tubercle on inner margin of pedipalp tibiotarsus trifurcate (Fig. 90d); China .....***S. triangulum* Lin, Zhang & Ji, 2001**

2 (1) Telofemora III-IV setal formula 4-3 .....**5**

– Telofemora III-IV setal formula 5-2; Philippines.....
.....***S. contiguus* Corpuz-Raros & Garcia, 1996**

3 (2) Genua II with 1 asl, 5 sts; dorsum with lateral scutella absent; Pakistan.....
.....***S. pigrus* Chaudhri, 1980**

– Genua II with 2 asl, 1 bsl, 5 sts; dorsum with lateral scutella present; Malaysia .....***S. exasperatus* (Shiba, 1978)**

4 (1) Basifemora I–IV setal formula 4-6-4-2; Telofemora I–IV setal formula 5-5-4-3; 4 pairs of dorsolateral hysterosomal plates present (Fig 91a) **5**

– Basifemora I–IV setal formula 5-5-4-3; Telofemora I–IV setal formula 5-5-5-2; 5 pairs of dorsolateral hysterosomal plates present (Fig. 91b); Luzon Is., Philippines.....***S. pentascutellus* Corpuz-Raros & Garcia, 1996**

5 (4) Pedipalp with entire tibiotarsus projecting past entomalae; bifurcate tubercle positioned halfway along the length of the tibiotarsus (Fig. 90b); Brazil .....
.....***S. braziliensis* Den Heyer, 1978**

– Pedipalp with distal 2/3 of tibiotarsus projecting past entomalae; bifurcate tubercle positioned on distal third of tibiotarsus (Fig. 90c); South Africa.....
.....***S. polyscutosus* Den Heyer, 1976**

Orangescirlinae Bu & Li, 1987

Orangescirula Bu & Li, 1987

Historical review. Bu and Li (1987a) erected Orangescirulinae and *Orangescirula* for a new species, *O. yongchuanensis*. Smiley (1992) described *O. kethleyi*. Corpuz-Raros (1996e) described *O. filipina*.

Diagnosis. *Gnathosoma*. **Pedipalps** 5-segmented and reach beyond the subcapitulum by at most the distal half of the tibiotarsi. Basifemoral seta simple or spine-like. Telofemoral seta spine-like. Pedipalps end in a stout claw. **Subcapitulum** bears 6 pairs of setae: 2 pairs of adoral setae and 4 pairs of subcapitular setae (hg_{1-4}). Setae hg_1 long and bent.

Idiosoma, dorsal. Proterosoma covered in a shield which bears 4 pairs of setae: 2 pairs of simple setae (*lps* and *mps*) and 2 pairs of setose sensilla (*at* and *pt*). Dorsal hysterosoma median plate present, fused to proterosomal shield; 1 to 5 pairs of dorsolateral plates present. Plates and shields smooth or reticulated. Seven pairs of setae present on the dorsal hysterosoma (c_1–f_1, c_2, h_2). Unsclerotized integument striated.

Idiosoma, ventral. **Coxae** I–II fused, coxae III–IV fused; coxae may coalesce medially for form a sternal shield. Each pair of coxae complemented with 3 pairs of setae. The genital plates each bear 4 setae; 2 pairs of genital papillae visible underneath the plates. 4–9 pairs of setae present on the integument between coxae II and the genital plates. Anal plates complemented with 2 pairs of setae (ps_{1-2}). Two pairs of setae (h_2, *pa*) located on the integument near the anal plates. Cupule *ih* present in close proximity to h_2. **Legs** shorter than idiosoma; they are never constricted apically so as to end in lobes. Trichobothrium on leg tibia IV present. Ambulacral claws on either side of a four-rayed empodium present.

Key to adult female *Orangescirula* (in part modified from Smiley 1992)

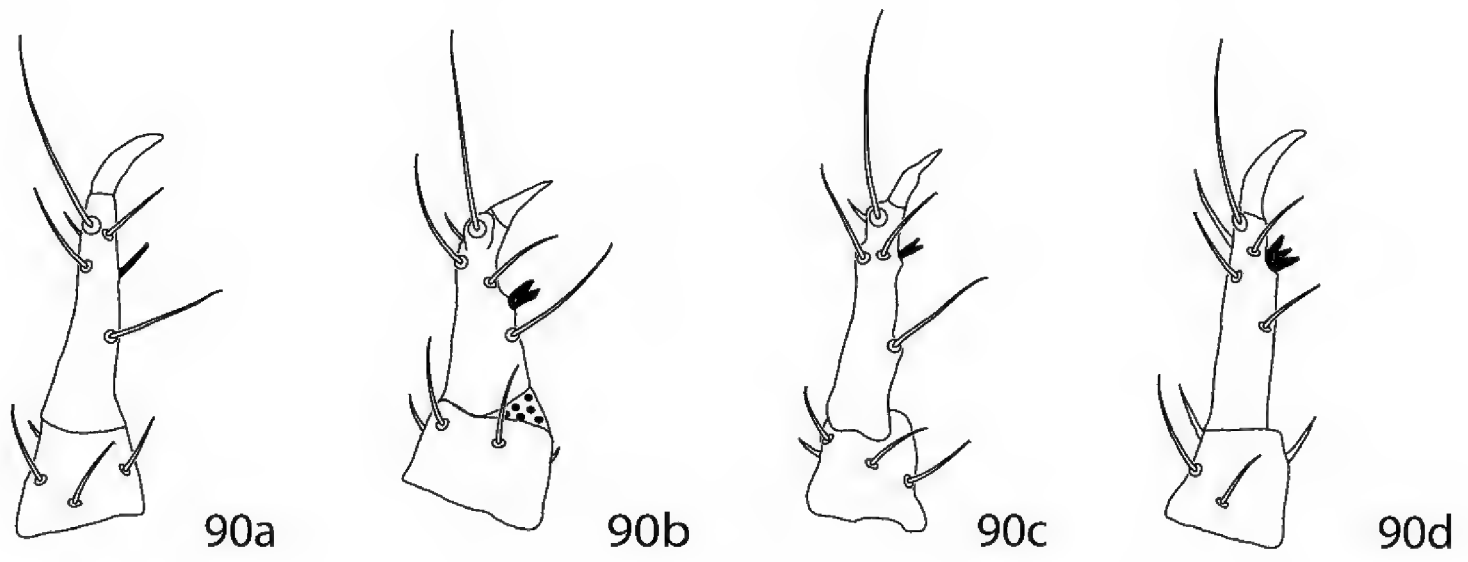
1	Pedipalpal basifemora seta simple ..... ***O. filipina***
–	Pedipalpal basifemora seta spine-like..... **2**
2 (1)	Dorsal shields with large subcuticular reticulations; 2 pairs of dorsolateral plates present ..... ***O. yongchuanensis***
–	Dorsal shield with extremely small subcuticular reticulations; 5 pairs of dorsolateral plates present..... ***O. kethleyi***

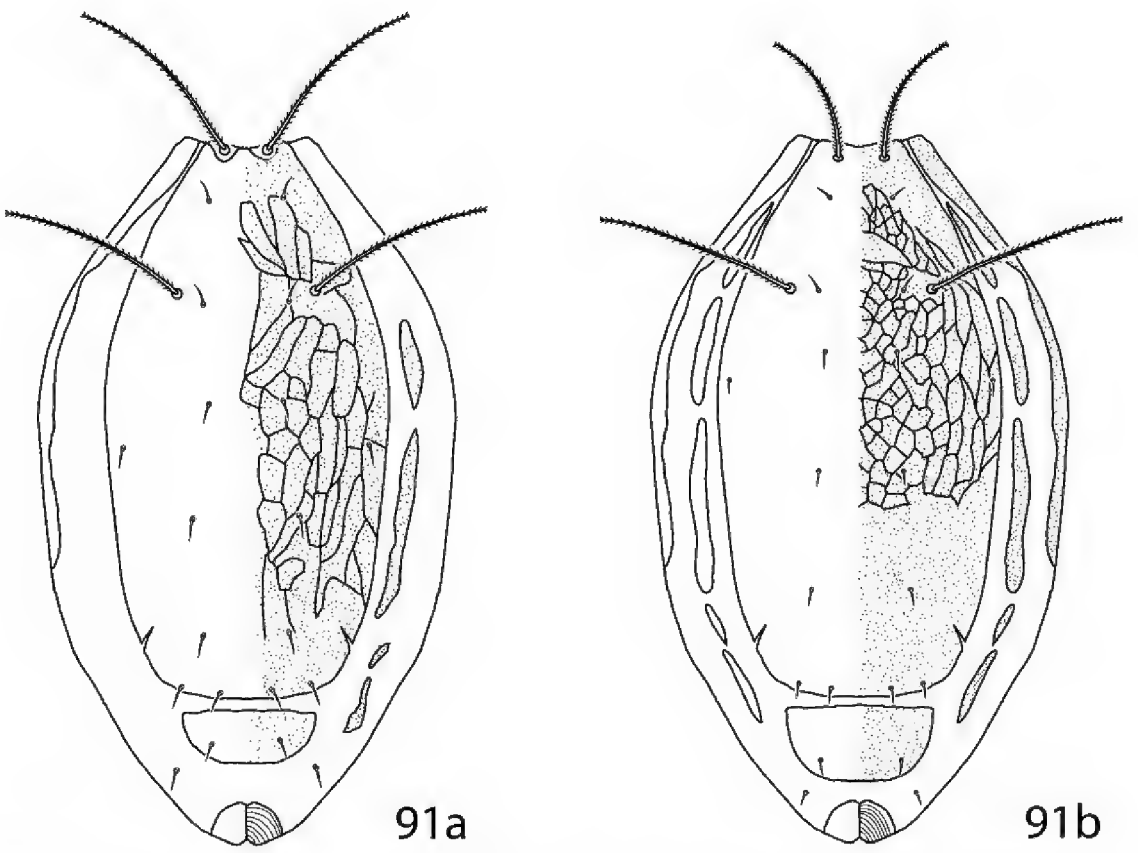
New locality data

Scirula papillata

Scirula papillata Lin, 1997: 169, Figs 1–6

Remarks. The specimens examined represent the first report of *Scirula papillata* from the Western Hemisphere. The specimens examined correspond to Lin's (1997) descrip-





Figures 90, 91. *Scutascirus* key illustrations. **90a** (after Corpuz-Raros and Garcia 1996). Pedipalp with tubercle not branched **90b** (after Den Heyer 1980b). Pedipalp tibiotarsus with bifurcate tubercle positioned halfway along the length of the segment **90c** (after Den Heyer 1980b). Pedipalp tibiotarsus with bifurcate tubercle positioned on distal third of segment **90d** (after Lin et al. 2001). Pedipalp tibiotarsus with trifurcate tubercle **90a** (after Den Heyer 1980b). Four pairs of dorsolateral hysterosomal plates present **91b** (after Corpuz-Raros and Garcia 1996). Five pairs of dorsolateral hysterosomal plates present.

tion except for telofemora I, which have 6 sts instead of 7 sts, and genua I, which have 9 setae (2 asl, 7 sts) instead of 8 setae.

Material examined (2 individuals on slides)**.** 1 female adult (APGD 10-0424-008, #135719), ex deciduous leaf litter, USA, Arkansas, Washington Co, Devil's Den State Park (35°46.817N, 94°14.750W), 24 April 2010, col. M. J. Skvarla • 1 female adult (APGD 10-0826-003, # 135720), ex thick moss by creek near deciduous litter (maple, oak), USA, Pennsylvania, Somerset Co, Laurel Hill State Park, 1985' elevation (40°00.963 N, 79°14.233 W), 26 August 2010, col. M. J. Skvarla.

Armascirus ozarkensis

Armascirus ozarkensis Skvarla & Dowling, 2012: 6, Figs 2–4.

Remarks. The specimens examined expand the range of this species within the Interior Highlands and are a new state record for Missouri.

Material examined (2 individuals on slides)**.** 1 adult female (APGD 11-1129-002), ex litter, USA, Arkansas, Bradley/Drew Co, Warren Prairie Natural Area, 21 June 2010, col. L. C. Thompson • 1 adult female (APGD 10-0523-004), ex litter, USA, Missouri, Taney Co (36°41'11.98"N, 92°58'16.44"W), 23 May 2010, col. J. R. Fisher, D. M. Keeler.

Armascirus primigenius

Armascirus primigenius Skvarla & Dowling, 2012: 13, Figs 8–10.

Remarks. The specimens examined significantly expand the range of this species within the United States. The Ouachita specimens correspond to Skvarla and Dowling's (2012) description except for genua IV, which have 1 asl, 5 sts instead of 1 asl, 4 sts.

Material examined (3 individuals on slides)**.** 1 adult female (APGD 13-0304-041, #131238), ex. Malaise trap in marsh, USA, Fairfax Co, George Washington Memorial Parkway, Dyke Marsh Wildlife Preserve, 11 April 2009, col. E. M. Barrows • 2 adult females (APGD 12-0706-002, #135716), ex very dry oak.pine litter in small, rocky depression, USA, Arkansas, Polk Co, Ouachita National Forest, Black Fork Mountain Wilderness, Black Fork Trail (34°41.312'N, 94°18.691'W), 6 July 2012, col. M. J. Skvarla.

Dactyloscirus dolichosetosus

Dactyloscirus dolichosetosus Den Heyer, 1979: 96, figs 71–77; Sepasgosarian 1984: 141; Smiley 1992: 223, Figs 117A, B; Castro 2008: 91; Skvarla and Dowling 2012: 30.

Remarks. The specimens examined significantly expand the range of this species within the United States.

Material examined (3 individuals on slides)**.** 2 adult females (APGD 12-1020-012, #135721), ex. deciduous litter (maple, sweet gum, poison ivy) in disturbed area, USA, Virginia, Fairfax Co, George Washington Memorial Parkway, Dyke Marsh Wildlife Preserve (38°46'25"N, 77°03'06"W), 22 October 2012, col. A. P. G. Dowling • 1 adult female (JRF 12-1028-010, #135722), ex. dry mixed litter with little tree cover in recently (~5 years) cut pine stand with shrubby oaks, USA, Arkansas, Montgomery Co, Ouachita National Forest (34°23'56", 93°51'22"), 28 October 2010, col. J. R. Fisher, D. M. Keeler.

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